Printed on Thin Paper for Foreign Circulation

MAY 8 1923

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXV.—No. 3513] LONDON: FRIDAY EVENING, APRIL 27, 1923 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Applications are Invited for the POST of ENGINEER to TAKE CHARGE of DESIGN.

Salary £300, rising by annual increments of £15 to £500 and full Civil Service bonus.

Present salary, including bonus, £440 16s. 10d.

The bonus corresponds to a cost of living index figure of 80 per cent., and is subject to an increase or decrease by 1/26th for every five points rise or fall in the index figure.

The post will carry superannuation benefits under the Federated Superannuation Scheme for Universities.

The candidate should possess good technical qualifications, a degree or diploma in engineering being desirable. Experience in engineering design for automobile or similar work is essential. A general knowledge of engineering shop practice and production methods will be taken into consideration.

Applications should be made to the SECRETARY of the ADMIRALTY (C.E. Branch), London, S.W. 1. 2254

Bideford Bridge Trust.

WIDENING OF BIDEFORD BRIDGE.

TENDERS are INVITED for the RECONSTRUCTION of the MASONRY CUTWATERS and FOUNDATIONS of BIDEFORD BRIDGE and for the WIDENING of the ROADWAY in REINFORCED CONCRETE.

Specifications and drawings may be seen at the office of the Bridge Steward, 24, Bridgeland-street, Bideford, and at the offices of Sir Douglas Fox and Partners, 28, Bedford-place, London, W.C. 1, on and after Monday, April 30th, 1923. Copies may be obtained at a charge of 15s., which is not returnable.

Sealed Tenders must be submitted to the Bridge Steward not later than Noon, May 22nd, 1923.

The Trust do not bind themselves to accept the lowest or any Tender.

H. M. BAZELEY,
Steward to the Bridge Trust.
24, Bridgeland-street, Bideford. P7925

Cardiff Corporation Water-Works.

TAFF FAWR SECTION.

PIPE LINE NO. 2.—CONTRACT NO. 1.

The Cardiff Corporation is prepared to receive TENDERS from competent and experienced persons whose names are on the King's Roll for the CONSTRUCTION, LAYING and COMPLETION of the No. 2 PIPE LINE, 1st Section, and other Works in connection therewith.

The line of pipes will commence near the foot of Castell Reservoir (Nant Ddu), Breconshire, and terminate at Goitre Coed, Quaker's Yard, Glamorgan, a length of approximately 14 miles of 28in. lap-welded steel tubes concrete lined.

Drawings may be seen and printed specification, form of Tender, and bill of quantities may be obtained on application to Mr. C. H. Priestley, M. Inst. C.E., City Hall, Cardiff, after the 2nd day of May next, on payment of a deposit of £20 to the City Treasurer, which will be returned after the receipt of a bona fide Tender with the bill of quantities fully priced out and the specification attached, but on that condition only.

Sealed Tenders, addressed to the Town Clerk, City Hall, Cardiff, and endorsed "Tender for No. 2 Pipe Line, Taff Fawr Section," are to be delivered not later than Twelve Noon on Saturday, the 26th May next.

The Corporation do not bind themselves to accept the lowest or any Tender.

No person should Tender unless he be properly qualified by practical skill and experience acquired as a master contractor in the construction of extensive public works.

Persons proposing to Tender are requested to send in their names at once to the Engineer, giving particulars of contracts carried out by them.

Dated this 23rd day of April, 1923.

CECIL G. BROWN,
Town Clerk.
2293

City of Bradford.

ELECTRICITY DEPARTMENT.

The Electricity Committee of the Bradford Corporation invite TENDERS for the PURCHASE and REMOVAL of ONE CROSS-COMPOUND CORLISS VERTICAL TOTALLY ENCLOSED ENGINE (by Musgrave, Bolton), coupled to a 1000 Kilowatt WESTINGHOUSE D.C. GENERATOR, together with CONDENSER, STEAM and OIL SEPARATORS, AIR PUMPS, BARRING ENGINE, certain PIPING, &c., and of ONE 380-Kilowatt WILLANS-E.C.C. D.C. GENERATING SET (without Condensing Plant or Piping), installed at the Electricity Generating Station, Valley-road, Bradford.

Form of Tender and abridged specification of the plant may be had on application to the City Electrical Engineer and Manager, at 45 to 53, Sunbridge-road, Bradford, to whom all inquiries respecting the plant should be addressed. The plant, which is in good running order, may be inspected any day, Monday to Friday inclusive, between the hours of 10 a.m. and 5 p.m., and on Saturday from 10 a.m. to 12 noon, and, if desired the 1000 K.W. Set, but not the 380 K.W. Set, can be run on load on application being made.

Sealed Tenders, endorsed "Tender for Generating Sets," to be sent to me not later than 10 a.m. on Friday, 11th May, 1923.

N. L. FLEMING, Town Clerk.
Town Hall, Bradford, 17th April, 1923. 2235

City of Bradford.

The Bradford Corporation invite TENDERS for the SUPPLY, DELIVERY, COMPLETE ERECTION, and SETTING to WORK of:—

CONTRACT "R. 218."—ONE 15,000/20,000 K.W. THREE-PHASE TURBO-GENERATOR, &c. (without Condensing Plant, which will be the subject of a separate contract).

Tenders must be for the whole of the work included in the contract.

Copies of the specification, conditions of contract, form of Tender, &c., may be obtained from Mr. Thomas Roles, M.I.E.E., City Electrical Engineer and Manager, Electricity Offices and Showrooms, 45 to 53, Sunbridge-road, Bradford, on payment of the sum of One Guinea. Additional copies of the specification, &c., may be obtained on payment of the sum of Half-a-Guinea per copy. The sums paid will only be refunded upon receipt of a bona fide Tender, with the return of all the documents in good condition and after the Tenders have been adjudicated upon.

Sealed Tenders, on the forms provided, must be sent, fully filled in, to me not later than 10 a.m. on Thursday, the 7th June, 1923, endorsed "Tender for Electricity Works, Contract 'R. 218.'"

The contract will be let subject to the fair contracts clauses of the Corporation, which may be seen at the Town Clerk's office, and which the accepted contractor will be required to sign.

The lowest or any Tender will not necessarily be accepted.

N. L. FLEMING, Town Clerk.
Town Hall, Bradford,
24th April, 1923. 2296

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Control of Boilers by Temperature and Draught Measurement.

Report on Indian Railways.

The Lakeside Electric Power Station at Milwaukee—No. III.

L. & N.E. Railway Pacific Type Locomotive —Details. (With a Two-Page Drawing).

Testing the Hardness of Metals.

Electric Transmission of Power for Propelling Machinery.

Powerful Floating Crane for India.

A New 30 Cwt. Lorry.

PUBLIC NOTICES

Metropolitan Borough of Shoreditch.

ELECTRICITY SUPPLY DEPARTMENT.

The Shoreditch Borough Council have FOR DISPOSAL certain old PLANT, including the following:—

ONE 165 K.W. Willans-E.C.C. DIRECT-COUPLED GENERATOR, 150 volts D.C.

FOUR 120 K.W. MOTOR TRANSFORMERS, with certain E.T. SWITCHGEAR.

FOUR 60 K.W. MOTOR TRANSFORMERS.

FOUR 33 K.W. MOTOR TRANSFORMERS.

ONE STEAM SUPERHEATER (partly dismantled).

Applications to view the plant should be made to the undersigned, from whom more detailed information can also be obtained, including conditions of sale, &c.

Tenders are to be made on the official forms (provided upon application) and are to be delivered by not later than Noon on Tuesday, the 8th May, 1923.

(Signed) C. NEWTON RUSSELL,
Borough Electrical Engineer.

Electricity Supply Department,
Coronet-street, Shoreditch, N. 1.
25th April, 1923. 2299

Teddington Urban District Council.

SUSPENSION BRIDGE.

The above Council invite TENDERS for WORKS in connection with the REPAIR of the SUSPENSION BRIDGE across the River Thames at Teddington.

Plans and specifications may be seen at the offices of Messrs. Mott, Hay and Anderson, of No. 9, Iddesleigh House, Caxton-street, Westminster, S.W. 1, where a form of Tender may be obtained after payment of a deposit of Five Guineas to the undersigned, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Suspension Bridge Repairs," to be delivered to the address hereunder not later than the 4th May, 1923.

The Council do not bind themselves to accept the lowest or any Tender.

G. H. SALMONS,
Clerk to the Council.
Council Offices, Teddington.
20th April, 1923. 2261

Department of Public Works,
Sydney, 31st January, 1923.

SYDNEY HARBOUR BRIDGE TENDERS—
EXTENSION OF TIME.

Tenders are Invited by the Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1650ft. in the clear, centre to centre of main piers, and a length of main bridge 2600ft. centre to centre of anchor piers. The total length of main bridge and approach spans included in Tender is 3810ft.; also an ALTERNATIVE TENDER for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of an ARCH BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1650ft. in the clear, centre to centre of bearings. The total length of main bridge and approach spans included in Tender is 3770ft. Either bridge is to provide for four lines of railway, six lines of vehicular traffic, and footway accommodation.

Copies of specification, including plans, technical information, general conditions, and Tender forms, may be obtained by bona fide tenderers on application to the Under-Secretary for Public Works, Sydney, or to the Agent-General for New South Wales, Australia House, The Strand, London; the Minister of Railways and Canals, Ottawa; the Australian Trade Commissioner in the United States, New York; or the Bureau of Foreign and Domestic Commerce, Washington, D.C., United States.

Tenders, the time for which has been extended, must reach the Under-Secretary for Public Works, Sydney, New South Wales, not later than 30th November, 1923.

R. T. BALL,
2035 Minister for Public Works and Railways.

PUBLIC NOTICES

9/3/23.

State Electricity Commission of Victoria, Australia.

TENDERS are INVITED for the MANUFACTURE, SUPPLY, DELIVERY, and SUPERINTENDENCE of ERECTION of the following:—

SPECIFICATION 23/63.—ELECTRICALLY OPERATED POWER SHOVEL.

Tender forms, specification, contract conditions, &c., are available upon application to—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C.

The charge per one set of two copies of the specification is £1, which will be refunded on receipt of a bona fide Tender and the return of all documents supplied.

Tenders, on prescribed forms, accompanied by a deposit of £50 and endorsed "Specification 23/63.—Electrically Operated Power Shovel," will be received up to Noon on the 31st July, 1923, by

R. LIDDELOW,
Secretary,
State Electricity Commission of Victoria,
22-32, William-street, Melbourne.

The Commission does not bind itself to accept the lowest or any Tender. 2206

The Great Indian Peninsula Railway Company.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

	Fee for Specification.
STEEL AXLES (FORGINGS) for CARRIAGES AND WAGONS	10s.
PLATELAYERS' TOOLS	10s.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Steel Axles," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 8th May, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2.
London, 25th April, 1923. 2308

Tyne Improvement Commission.

POLICE STEAM LAUNCH.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION and DELIVERY in the Tyne of a SINGLE-SCREW STEAM LAUNCH, about 57ft. long, 11ft. beam, speed 11 or, alternatively, 13 knots, with cabin and crew accommodation, &c.

Copies of the form of Tender, conditions of contract, general specification and outline drawing may be obtained from this office on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Steam Launch," must be delivered at the undermentioned offices, addressed "The Chairman, Collision Sub-Committee," not later than Noon on the 25th day of May, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.

Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne.
23rd April, 1923. 2277

"THE ENGINEER" WANTED.

WANTED, a COPY of "THE ENGINEER" Dated December 26th, 1919.—Address, P5000 The Engineer Office. P5000

PUBLIC NOTICES

County Borough of Warrington.

ELECTRICITY DEPARTMENT.

PLANT FOR SALE.

The Electricity and Tramways Committee invite TENDERS for TWO 250 K.W. WILLANS-BRUCE PEEBLES GENERATING SETS, direct current, 450/550 volts.

Full particulars and form of Tender may be obtained on application to F. V. L. Mathias, Borough Electrical and Tramways Engineer, Electricity Works, Warrington, where the plant may be seen by appointment.

Tenders, addressed to the "Chairman of the Electricity and Tramways Committee," Town Hall, Warrington, must be sealed with wax and endorsed "Tender for Generating Sets" and delivered not later than Twelve Noon on Tuesday, 29th May, 1923.

The Committee do not bind themselves to accept the highest or any Tender.

A. T. HALLAWAY,
Town Clerk.
Town Hall, Warrington. 2316

Southport, Birkdale, and West Lancashire Water Board.

DISTRIBUTION SUPERINTENDENT.

APPLICATIONS are INVITED from persons with the necessary qualifications and experience for the above APPOINTMENT at a salary of £250 per annum.

Applicants must have up-to-date practical experience in main laying and repairing, plumbing and fitting inspection, waste detection and prevention, and the control of the outdoor staff and workmen of a waterworks undertaking.

Applications, in own writing, stating age, full particulars of experience and present employment, and accompanied by recent testimonials, should reach the undersigned not later than the 14th May, 1923.

C. BURTON EDE, Assoc. M. Inst. C.E.,
Engineer and Manager.
14, Portland-street, Southport.
April 23rd, 1923. 2274

SITUATIONS OPEN

WANTED by a Leading Boiler Insurance Company, additional BOILER INSPECTORS. Applicants must be practical engineers with a technical training, capable of making accurately dimensioned sketches of all classes of steam boilers, and writing clear reports on conditions. Commencing salary £260 per annum.—Address, 2279, The Engineer Office. 2279 A

WANTED by London Sales Office of an American Engineering Firm, ENGINEERING SALES CORRESPONDENT, about 25 years of age. Salary £4 per week to the right man. Public school man wishing opening with a good future will be given preference.—Address, stating qualifications, 2290, The Engineer Office. 2290 A

WANTED IMMEDIATELY, CONTRACTOR'S ENGINEER for measuring up quantities and setting out and giving levels of Sewers and Road Work. Good previous experience absolutely essential. Salary £7 per week.—Write, stating age and full particulars, to Box 346, c/o Brown's, 39, Tothill-street, S.W. 1. 2256 A

WANTED in Progress Department of Large Manufacturers in the Midlands, employing several thousand hands, the SERVICES of a First-class MAN to TAKE CHARGE. Essential that applicant should have a good knowledge of modern workshop manufacturing methods. State age, experience, and salary required.—Address, 2317, The Engineer Office. 2317 A

A GENERAL MANAGER, for Well-established and prosperous Firm of General Mechanical and Electrical Engineers in Midlands. Must be well educated, fully qualified in every way, and have had experience of Colliery Work and Plant. REQUIRED to Take full Control of Works, having up-to-date commercial knowledge, capable of advising customers, and carrying out their orders.

The company has an excellent connection with collieries, brickworks, &c., is well known as makers of all mining machinery, plant and constructional work, also as electric light and power contractors.

There is plenty of work on hand, and the appointment offers excellent opportunities and unlimited scope for advancement for an intelligent, keen, capable man with organising ability and imagination.

Good salary and excellent prospects.

Address, stating age, detailed experience, and salary required, 2272, The Engineer Office. 2272 A

A LEADING REINFORCED CONCRETE COMPANY REQUIRE the SERVICES of a REPRESENTATIVE for Scotland to work from their Glasgow office. Applicants must be well connected and should have a knowledge of Reinforced Concrete or Constructional Engineering. Preference will be given to Scotsmen resident in or near Glasgow. Applications to state age, qualifications, and salary required.—Address, 2278, The Engineer Office. 2278 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Page 2.

PARTNERSHIPS, Page 2.

PATENTS, Page 3.

MACHINERY, &c., WANTED, Page 2.

FOR SALE, Pages 3 and 4.

AUCTIONS, Pages 3 and 102.

PREMISES TO LET OR WANTED Page 3.

WORK WANTED, Page 4.

AGENCIES, Page 2.

MISCELLANEOUS, Page 2.

For Advertisement Rates See Page 449, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page 101.

SITUATIONS OPEN (continued)

GENERAL MANAGER WANTED for Burma, for Engineering Works and Stores there, doing general engineering business. Term of engagement under agreement.—Address, stating age, qualifications, training, and salary expected, P7341, The Engineer Office. P7341 A

LIVE REPRESENTATIVE REQUIRED for the Midlands for the sale of high-class Woodworking Machines. Permanent situation. Send fullest particulars, stating age, previous experience (if any), salary and commission required, in confidence.—Address, P7360, The Engineer Office. P7360 A

METALLURGICAL CHEMIST.—A Thoroughly competent MAN is REQUIRED with the necessary knowledge and experience to control the Chemical and Physical Laboratory and Heat Treatment Department of an important Motor Car Works near London. All replies to state experience in full, giving age and salary required.—Address, 2193, The Engineer Office. 2193 A

RATEFIXER, with Wide Experience in Switchgear assembly operations. Only competent and highly trained men possessing substantial experience of this class of work will be considered. Good prospects for suitable man. State age, details of training and experience, and salary required.—Address, 2259, The Engineer Office. 2259 A

WORKS MANAGER WANTED for Engineering Works and Foundry, specialising in heavy non-repetition work, i.e., Reversing Rolling Mill Engines, Large Gas Engines, Uniflow and other Steam Engines, &c. Must be capable organiser with foundry experience.—Address, stating age, experience, salary required, The GENERAL MANAGER, Galloways Ltd., Knott Mill Ironworks, Manchester, marking envelopes "Works Manager." 2201 A

WANTED, First-class CRANE DRAUGHTSMAN, well up in Steam and Electric Cranes. No one who has not specialised in this class of work need apply. State experience and wages required.—SAMUEL BUTTLER and CO., Ltd., Orangefield Works, Stanningley, Leeds. 2287 A

WANTED, First-class DRAUGHTSMAN, Thoroughly conversant with Machine-cut Gearing and its application.—Apply, stating age, full experience, and salary required. Only competent men need apply.—DAVID BROWN and SONS (Huddfd.), Ltd., Park Gear Works, Lockwood, Huddersfield. 2218 A

WANTED IMMEDIATELY in London, JUNIOR DRAUGHTSMAN, with experience in Electrical Work and the Lay-out and Design of Steam Generating Stations.—Address, stating age, experience, salary, and when free, 2419, The Engineer Office. 2319 A

A LEADING CARRIAGE and WAGON DRAUGHTSMAN REQUIRED by important Argentine Railway: must be capable of taking charge during absence of ch of: age 28-34; salary £400-£450, with an additional £50 when able to converse in Spanish; free first-class passage.—Write, stating age, education, training, experience, &c., to Box "B. E.," c/o Davies and Co., 95, Bishopsgate, E.C. 2. 2300 A

APPLICATIONS are INVITED by Manchester Engineering Firm for the POSITION of DRAUGHTSMAN with good general engineering knowledge and experience and familiar with Steam Plant, Pipe Work Lay-out and Details. Age 24/40. Electrical experience an advantage. State age, experience, and salary required.—Address, 2222, The Engineer Office. 2222 A

CAPABLE DRAUGHTSMAN REQUIRED by Lancashire Firm; one with experience in design and details of Power Station Plant, Water-tube Boilers, Chain-grate Stokers, Coal and Ash-handling Machinery.—Address, stating age, salary required, experience, references, 2269, The Engineer Office. 2269 A

COMPETENT DRAUGHTSMAN WANTED, Preferably experienced in Loco, Steam and Electric Cranes. Applications to state age, training, experience, and salary required.—GRAFTON and CO., Engineers, Bedford. 2286 A

DRAUGHTSMAN, Experienced in Design and Construction of Suction Grain Elevators. Temporary engagement offered by firm of Elevator and Conveyor Engineers, to Plan a Small Special Installation.—Address, 2316, The Engineer Office. 2316 A

DRAUGHTSMAN REQUIRED, Experienced in Rotary Printing Press Work.—Write full particulars, R. HOE and CO., Ltd., 109, Borough-road, London. 2220 A

DRAUGHTSMAN REQUIRED for Heavy Oil Engine Design; must be experienced in this class of work; knowledge of heavy gearing an advantage. Applicants must be capable and energetic, with ability to develop and perfect designs on own initiative. Give full particulars of experience, age, and salary required.—Address, "OIL," Wm. Porteous and Co., Advertising Agents, Glasgow. P7338 A

DRAUGHTSMAN REQUIRED. Must have Experience in Air-cooled Aero-engine Designing. State age, experience, and salary required.—G.P.O., Box 77, Bristol. 2315 A

DRAUGHTSMAN, Senior, for Large A.C. Machines and Rotary Converters.—Address, stating age, experience, and salary required, 2314, The Engineer Office. 2.14 A

DRAUGHTSMEN, SEVERAL, Experienced Marine auxiliary, WANTED AT ONCE for the Eastern Midlands; must be well up in Marine Engine-room Auxiliary Equipment, particularly Pump Work. State age, experience, and salary required.—Address, 2312, The Engineer Office. 2312 A

DRAUGHTSMEN, Structural Steel, REQUIRED AT ONCE for Bridge Works, Glasgow. Experienced men wanted; heavy buildings and bridge work.—Address, "BRIDGE," Wm. Porteous and Co., Advertising Agents, Glasgow. P7340 A

DRAUGHTSMAN WANTED IMMEDIATELY, Experienced in the design of high-class Petrol Engines. Preference given to man accustomed to Aero-engine Work. Applications from first-class men only will be considered. State age, details of experience, and salary required.—Address, "PETROL," Wm. Porteous and Co., Advertising Agents, Glasgow. P7332 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the Design of Colliery Electric Winding Engines and Haulage Gears (mechanical portions). —Write, stating age, experience, and salary required, Box 1578, Sell's Advertising Offices, Fleet-street, E.C. 4. 2202 A

DRAUGHTSMAN WANTED, with First-class Experience in the design of large Material Handling and Conveying Plant. Must have good experience in the design of structural and mechanical work in connection with same.—Apply by letter in first instance, stating age, experience, and salary required to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 2256 A

DRAUGHTSMAN WANTED, with First-class Experience in the design of large Electric Jib and Overhead Cranes. Must be capable of taking out own estimates and quantities and putting work in hand in shops.—Apply by letter in first instance, stating age, experience, and salary required, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 2257 A

DRAUGHTSMAN WANTED for Constructional Steel Work, used to London work, experienced in shop detailing.—Apply by letter, with qualifications, references, and salary required, to H. YOUNG and CO., Ltd., 4/6, Wandsworth-road, S.W. 8. 2310 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN, with Good Knowledge Traction Motors, Electric Vehicles, &c., capable of planning and designing Jig and Tool Lay-outs. Only those with good electrical experience need apply. £5 per 41 hours' week. London district.—Address, 2311, The Engineer Office. 2311 A

EXPERIENCED DRAUGHTSMAN REQUIRED, accustomed to designing and detailing all kinds of Electric Cranes. Permanent and progressive position to competent man.—Apply, stating age, experience, and salary, to THOMAS SMITH and SONS (Bodley), Ltd., Steam and Electric Crane Works, Bedley, near Leeds. 2307 A

EXPERIENCED AERIAL ROPEWAY DRAUGHTSMAN WANTED for responsible position in London drawing-office.—Address, giving outline of experience, age, and salary required, 2280, The Engineer Office. 2280 A

FULLY Experienced Light Structural DRAUGHTSMAN REQUIRED AT ONCE for London office. Must be quick and accurate worker. Good prospects for right man.—Address, giving experience, age, salary required, and when at liberty, 2281, The Engineer Office. 2281 A

JIG and TOOL DRAUGHTSMAN WANTED. Must have had extensive experience on the production of Tools and Fixtures for the manufacture of Electric Generators and Motors.—Reply, stating age, experience, and salary required, to "EMPLOYMENT," Metropolitan-Vickers Electrical Co., Ltd., River Don Works, Sheffield. 2289 A

JUNIOR DRAUGHTSMAN, Good, for London Office. —Write fully, stating experience and salary expected.—Address, P7338, The Engineer Office. P7338 A

LEADING DRAUGHTSMAN WANTED for Leeds. Must be thoroughly experienced in the design of both Narrow and Broad-gauge Steam Locomotives up to 60 tons. State age, experience, and salary required. Good prospects for suitable man.—Address, 2255, The Engineer Office. 2255 A

MACHINE TOOL DRAUGHTSMAN REQUIRED for Special Tools, Jigs and Fixtures. Applications are only invited from men of first-class ability. Please state experience and salary expected.—Address, 2178, The Engineer Office. 2178 A

WANTED, FOREMAN MOULDER, with Full knowledge of manufacture of High-grade Iron Castings, such as steam cylinders, bed frames, condensers, &c., capable of taking charge of capolas, moulding machines and plate moulding. He must also have had experience in the production of Bronze and Gun-metal Castings to Admiralty specification, and must be capable of supervising the mixing of metals. Applicant to state previous experience, &c., and to supply references.—Address, 2294, The Engineer Office. 2294 A

SITUATIONS WANTED

ADVERTISER (37) SEEKS POST; 21 Years' experience in manufacture of telephones, electrical gear, &c. Has held positions as tool-room foreman, chief designer, planning engineer, and shop superintendent with leading firms.

Expert knowledge all classes press work and shop processes and wide experience in laying out new productions.

Address, P7336, The Engineer Office. P7336 B

BUYER (39), 21 Years' Technical and Commercial experience in mechanical and electrical engineers' stores, metals, tools and works requisites; systematical organiser, good correspondent, wide knowledge of markets.—Address, P7355, The Engineer Office. P7355 B

CIVIL ENGINEER, Located London, 20 Years' active experience on public works, including 9 in U.S.A., embracing surveys, reports, designs and in charge of construction, DESIRES TECHNICAL APPOINTMENT with financial corporation or would Represent Non-resident Americans having British interests.—Address, P7326, The Engineer Office. P7326 B

ENGINEER DESIGNER, Air Compressors, SEEKS a permanent and progressive POST with manufacturers or London office.—Address, P7334, The Engineer Office. P7334 B

ENGINEER, Excellent Long-service Record as Foreman, draughtsman and works manager with general engineers and ironfounders, SEEKS RESPONSIBLE POSITION; well-educated, energetic, successful organiser and controller of labour.—Address, P7266, The Engineer Office. P7266 B

ENGINEER (23), G.I. Mech. E., City and Guilds, Finsbury, drawing-office, shops, R.A.F., M.T., REQUIRES POSITION, London, office, works or sales.—Address, P7323, The Engineer Office. P7323 B

ENGINEER, with Practical Experience, Home and abroad proceeding Australia, DESIRES AGENCIES from reputable firm.—Address, P7329, The Engineer Office. P7329 B

ENGINEER, with Works, Drawing-office and Wide commercial experience, living on the North-East Coast, who makes regular journeys to all parts of the country on behalf of a company of which he is a director, would UNDERTAKE further WORK of same character. Good connection among the most important firms in the country and thoroughly able to handle matters with tact and discretion.—Address, P7339, The Engineer Office. P7339 B

ENGINEER (Working) SEEKS SITUATION. Good all-round experience, fitting, turning, charge of plant; 1st Class B.O.T. Certificate.—FRANKLIN, 3, Riverdale-road, Twickenham, Middlesex. P7353 B

GENERAL or WORKS MANAGER, 18 Years' Experience motor trade, REQUIRES POSITION with firm of manufacturers or engineers. Similar position held for many years with success. Wide technical knowledge of designing, construction, coach building and modern production methods. Proved successful methods of producing for profit. Salary by arrangement.—Address, P7328, The Engineer Office. P7328 B

INSPECTION DEPT.—Keen MAN, 16 Years' Exp., thorough knowledge modern machine shop and inspection methods (automobile and electrical); Vickers, Rolls-Royce and Vauxhall experience.—Address, P7258, The Engineer Office. P7258 B

JOHN HEATH, Cuthworth Lodge, Newdigate, Surrey, having 21 years' experience of interchangeable production as chief designer, purchaser and works superintendent, &c., accustomed to control large staffs, OFFERS SERVICES in similar capacity or as London Representative. Inquiries solicited. P7227 B

MECHANICAL ENGINEER, Degree M.E., DESIRES return ENGAGEMENT for India. Nine years' experience designer and engineer, American steel and allied companies, blast-furnaces, open-hearth furnaces, rolling mills, buildings; three years' recent experience engineer large Indian steel company. Present engagement development engineer prominent firm American engineers.—Reply, J. V. McCartney, 4554, Malden-street, Chicago, Ill., U.S.A. 2271 B

M.I. Mech. E., Now Disengaged, DESIRES POSITION as GENERAL MANAGER, WORKS MANAGER, or other Responsible Post at home or abroad.

Bachelor, speaks French fluently; exceptional knowledge of mass production; 6 years as assistant and over 8 years as works manager with important firm engaged on accurate interchangeable work; also recent experience in France on textile machinery and general engineering.

Tactful and successful in dealings with staff and workpeople.

Business capacity and commercial experience.

Please address, P7267, The Engineer Office. P7267 B

SITUATIONS WANTED (continued)

WILL ANYONE OFFER ENGINEER EMPLOYMENT? All-round prac., tech., mech., marine exp.; held positions works and chief engineer; accept any berth with some prospects. Clean record, irreproachable refs., extra 1st class cert. B.O.T., 35, married.—J. S. M., Everton, Coleridge-road, Ashford, Middlesex. P7316 B

WORKING ENGINEER SEEKS RE-ENGAGEMENT, to run brewery or factory plants, steam or suction gas; good all-round shop experience (own repairs).—Address, P7354, The Engineer Office. P7354 B

WORKS or GENERAL MANAGER, Successful organiser, with many years exceptionally wide experience in both capacities and as chief engineer, WANTS ENGAGEMENT, general engineering, large weldless tubes, hydraulic forging, steel plant and manufacture; commercial experience.—Address, P7225, The Engineer Office. P7225 B

WORKS MANAGER, with 19 Years' Engineering experience in responsible positions both at home and abroad, WISHES CHANGE. Capable, good organiser, speaks four languages; in present position for over 3 years; well acquainted with up-to-date mass production in machine, press shops and cabinet mill. London district preferred.—Address, P7291, The Engineer Office. P7291 B

DRAUGHTSMAN (London District) SEEKS SITUATION; 15 years' good all-round engineering experience in shops and drawing-office.—Address, P7356, The Engineer Office. P7356 B

DRAUGHTSMAN (22), Shop 2 Years, D.O. 3 Years, experience jigs and tools, die casting and general engineering, REQUIRES suitable POSITION.—Address, P7359, The Engineer Office. P7359 B

ENGINEER DRAUGHTSMAN (36) WANTS POST. Ten years' supervision of department and D.O., general engineering, foundry, railway experience; first-class references.—Address, P7245, The Engineer Office. P7245 B

JUNIOR MECHANICAL DRAUGHTSMAN (Age 1911, 34 years) D.O. exp. and 3 years engineering school. London district.—Address, P7350, The Engineer Office. P7350 B

COMMERCIAL RECONSTRUCTIONS LTD.,
1, POST OFFICE CHAMBERS, DERBY.
Manufacturing and Financial Consultants.
Expert assistance on all works, technical and commercial problems. Production, Costings and Sales. Businesses reorganised and reconstructed. Capital issues and Finance. Ex.

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.
Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.
Established seventy years.

PARTNERSHIPS, DIRECTORSHIPS WANTED in businesses showing audited books, seeking not less than £2000. April list of investors sent; £2000 to £10,000 available.—OFFICERS' PARTNERSHIP GUARDIAN, Ltd., 48, Dover-street, W. 1. Calls imperative. 2253 C

AGENCIES

WANTED, LONDON AGENT by a Sheffield Firm, well known. Must have a first-class connection, high-speed, crucible and alloy steels, &c., &c. Mainly commission. Good opportunity for right man.—Send full particulars in confidence to Box 576, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 2283 D

LIVE FIRM of ENGINEERS, with Centrally situated offices and showrooms in Leeds, 20 years' experience and connection with engineers, shipbuilders, collieries, &c., are DESIROUS of REPRESENTING in Yorkshire and North of England a well-known FIRM of ENGINEERS, on commission and an allowance for office expenses.—Address, P7236, The Engineer Office. P7236 D

LONDON SALES AGENTS, with Live Connection amongst manufacturing engineers and merchants, DESIRE a further AGENCY for suitable commodity.—Address, P7305, The Engineer Office. P7305 D

STOCKHOLM FIRM, with Good Connections, is DESIROUS of REPRESENTING BRITISH MANUFACTURER of MACHINERY, MACHINERY REQUISITES and CHEMICALS. Address, 2282, The Engineer Office. 2282 D

TWIST DRILLS.—One of the Oldest MANUFACTURERS REQUIRES Established AGENTS or TRAVELLERS with first-class connections. Commission basis, but quality and price equal any on world's market. Stockists preferred.—Address, P7342, The Engineer Office. P7342 D

MISCELLANEOUS

ANALYSIS and PHYSICAL TESTING of METALS, &c. Prompt and accurate reports. Certificated chemists only employed. Moderate fees.—BECROFT and PARTNERS, Ltd., 84, Peter's Close, Sheffield. 1529 I

ENGINEERS, Established London Thirty Years, DEVELOP Technically and Commercially Sound ENGINEERING IDEAS on mutual basis.—Communicate first instance to Box E. 468, c/o Dawson's, 121, Cannon-street, E.C. 4. 2011 I

INVENTORS REQUIRING TECHNICAL ASSISTANCE should apply to DE FRAINE and CLARK, Scientific Engineers, 23, Old Queen-street, Westminster, who will advise design and carry out experimental work. Victoria 858. P7316 I

IF YOU REQUIRE DIVIDING HEADS for MILLING, ROTARY TABLES for SLOTTING and MILLING.
Write to
THE WHEELER MNFG. CO. Ltd.,
65F, Trench Crossing, Wellington, Salop.

COMPANY MEETING

English Electric Company.

SIR CHARLES ELLIS, Chairman of the Company, who presided at the Annual General Meeting, April 25th, said, in moving the adoption of the report and accounts, that the past year was one of the worst the engineering trade had ever experienced, so that he thought it was a satisfactory result to show a balance on profit and loss account of £318,264, as compared with £368,459 for the previous year. It was proposed to pay a dividend of 5 per cent, on the Ordinary Shares and to carry forward £68,972, as compared with £55,599 brought forward from 1921. A special number of the "English Electric Journal" had been distributed to the Shareholders in order to give them a plain and simple record of what the Company was doing. When he addressed them last year he emphasised the need for prudence and the avoidance of too optimistic an attitude, and subsequent events had justified the prediction that the upward lift of trade, although steady, would be long and tedious. The distribution of their productive activities over a number of works made it possible more easily to adjust productive capacity to the trade situation, and had enabled them to effect, with the maximum of advantage and the minimum of disturbance, what might otherwise have seemed the too drastic economy of concentrating on four of their factories and temporarily closing down the fifth. The orders received during the year were in value one and three-quarter times those received in the previous year, and in the first three months of this year the improvement had been more than maintained. Last year the bulk of the turnover came from public works, owing to the inability of the private buyer to finance new developments; but this year there had been a most encouraging revival in the application of their standard manufactures to steel works, coal mines and other industries. Improvements in designs and the development of new lines of machinery had been actively continued and had assisted the Company in obtaining contracts particularly in electric railway and water power work. Glancing at contracts of special interest, he was glad to say that entire satisfaction had been given by the electric locomotives now in regular operation in the Pyrenees service of the Midi Railway of France. Motor coach equipments had been tested on the Catalana Railway in the neighbourhood of Barcelona, and others would shortly be working in France, Holland and Japan. After a prolonged inquiry, the Japanese Government Railways had decided to adopt the high-tension direct-current system and had placed with this Company an order for 94 electric locomotives, the largest order of the kind ever executed entirely by British manufacturers. More recently the contract had been secured from the Great Indian Peninsular Railway for electrical equipments for the suburban lines in and near Bombay. In the department of hydro-electric work they had now on their staff specialist engineers and they owned valuable patents. For India they were building a 15,000 H.P. water turbine, while for Brazil they had an order for one of 25,000 H.P., with the alternator to be driven by it. In this country the steam turbine and internal combustion engine were likely to remain the principal prime movers for the generation of electricity. During the year they completed the revision of their designs and now had under construction both large and small units, which in efficiency were in the first rank. In December they completed the new power station for the Leicester Corporation, and they were now working on a similar contract for the Preston Corporation. In the field of internal combustion engines they had developed the Fullagar Opposed-piston Engine. They were sparing no effort to extend old markets and create new ones. They had maintained excellent relations during the year with their workpeople, and with a continuance of the present spirit of co-operation the Company could look confidently to the future. 2296

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—8/11, Trafford Chambers, 58, South John-street, LIVERPOOL. Ex. B

ENGINEERING EXAMINATIONS.—Day, Evening or Correspondence Courses of Preparation for all Examinations. Thousands of successes during the past eighteen years.—G. P. KNOWLES, M.B.E., B.Sc., A.M.I.C.E., &c., 39, Victoria-street, Westminster, S.W. 1. Ex.

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Rlys.), Hollybank, Woking. P6954 B

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. passes last examination. Reinforced Concrete, new comprehensive course under expert engineer, 5s. 6d. Write for particulars.—PENNINGTONS, University Tutors, 254 Oxford-road, Manchester. Estab 1870 Ex.

MACHINERY, &c., WANTED

WANTED, a New or Good Second-hand 20-TON WEIGHBRIDGE, 20ft. by 8ft., first-class maker.—Address price, condition, and full particulars, P7335, The Engineer Office. P7335 F

WANTED IMMEDIATELY, 12in., 13in. or 14in. Four-wheeled LOCOMOTIVE, 14in. preferred; only good engines entertained.—Address particulars, 2292, The Engineer Office. 2292 F

WANTED, Large DOUBLE-ACTION TOGGLE DRAWING PRESS, 500-ton to 1000-ton capacity. Photographs and general dimensions.—JOHN THOMPSON MOTOR PRESSINGS, Ltd., Beacon Works, Wolverhampton. 2260 F

WANTED, PLANER, 16ft. by 7ft. Between housings by 5ft. Must be a modern machine with three or four heads.—Address, 2174, The Engineer Office. 2174 F

WANTED, SUCTION GAS and OIL ENGINES, good second-hand, at cash bargain prices, f.o.b. Crossley's later numbers preferred.—CURUVILLA BROS., Kemerom, Kottayam, P.O., India. Cables, Cassegine, Kottayam. 1870 F

WANTED, Second-hand 1500-TON HYDRAULIC PRESS, 6ft. stroke.—Address full particulars and price, 2177, The Engineer Office. 2177 F

COLLIERY WAGON MAKING.—COMPLETE PLANT WANTED, URGENTLY.—Address full details at once, 2173, The Engineer Office. 2173 F

REQUIRED, USE of OPEN-HEARTH FURNACE, 4 to 5 tons, for experimental purposes, with the option of purchasing. State locality, terms, &c.—Address, 2276, The Engineer Office. 2276 F

SECOND-HAND BOILER SHELL DRILLING MACHINE, multiple spindles, with circular table, to take up to 10ft. 6in. dia. by 10ft. 6in. high.

Also Modern High-speed PLATE EDGE PLANING MACHINE with hydraulic rams, to take up to 30ft. or 35ft. long, suitable for direct electric drive. Machines must be in first-class condition.

Address, RUSTON and HORNSBY, Ltd., Lincoln. 2288 F

For continuation of Small Advertisements see page 3

The Lakeside Electric Power Station at Milwaukee.

No. III.*

TURBO-GENERATOR unit No. 1, of 20,000-kilowatt capacity, installed on its massive concrete foundation, is shown in Fig. 18, page 448. The second unit is parallel with it and on the opposite side of the condenser pit, shown at the left. See also the cross section—Fig. 13 *ante*. These units were built by the General Electric Company, of Schenectady.

The two main generators are rated at 20,000 kilowatts, 80 per cent. power factor, three-phase, 13,200 volts, 60 cycles, and are driven at 1800 revolutions per minute. The field excitation, which is at 240 volts, is furnished normally from the direct-connected exciter of 110 kilowatts capacity. If this should fail, the field control panels would automatically cut out the exciter and cut in emergency excitation from the 240-volt direct-current station power supply. To protect the generators from serious injury, due to insulation failures, they are cut off automatically in case of internal troubles. For this purpose, both ends of each phase winding are brought out to the terminal boards to permit the installation of current transformers in the neutral connections.

ELECTRICAL EQUIPMENT.

These transformers, and others installed in the main generator leads, are connected to relays. In normal operation no current passes through the relays. With trouble in the generator windings one transformer will carry more current than the others, and the unbalanced current will pass through the relays, thus opening the main generator and field circuit breakers. Generator neutrals are connected to ground through a 3-ohm resistance in order to limit the current to ground in case of line trouble and thus reduce the severity of such trouble. The oil switch control system is 120 volts direct-current supplied normally from a separate storage battery and special motor-generator sets. If necessary this control can be transferred immediately to the battery on the direct-current station power system by connecting it across half of the cells.

There are two main bus-bars with sectionalising switches between generator sections. All 13,200-volt bare copper and cables are taped with ¼in. of varnished cambric and covered with a layer of cotton tape impregnated with a fire-resisting substance. Each generator may be connected to either main bus through selector oil circuit breakers. Feeders are connected in groups of three to feeder group bus-bars, which in turn may be connected to the main bus-bars through group oil circuit breakers. The main circuit breakers are widely separated, with three to four groups of feeder breakers between them, so that trouble on one main set will not be communicated to another main set. Similarly, the group breakers of any one feeder group are separated as far as possible from one another.

On the fourth floor of the switch-house are arranged the oil-circuit breaker mechanisms, with the breakers on the third floor. Main bus-bars, potential transformers, feeder current transformers, feeder reactors and feeder group bars are on the second floor. On the first or ground floor are the generator current transformers, feeder lightning arresters, feeder potheads and disconnecting switches. The generator leads pass out horizontally from the machine foundation through a tunnel under the switch-house and then rise to the generator selector bus on the second floor. Each of these leads consists of two 1,000,000 cir. mil. single conductor, stranded copper cables insulated with cambric and covered with a flame-proof braid. From the current transformers to the main circuit breakers the leads consist of two ¼in. copper bars 3in. wide. The main generator oil-circuit breakers are rated at 2000 ampères, 15,000 volts, and are capable of rupturing 18,000 ampères at the rated voltage. Each pole of the breaker is in a separate compartment, and the crossheads are in another compartment under the operating mechanism on the fourth floor. The main bus-bars are on either side of the room, so that trouble on one set will not affect the other. They consist of ¼in. copper bars 4in. wide, suspended on porcelain insulators and separated by 2in. barriers of gypsum.

Feeders are tapped off between the group oil-circuit breakers. Conductors run from the feeder bus through porcelain bushings in the wall, up to the circuit breakers and down through current transformers and feeder reactors to the disconnecting switches and cable terminals. Group circuit breakers are rated at 800 ampères, 15,000 volts, with a rupturing capacity of 18,000 ampères at rated voltage. The crossheads are arranged in the same way as those of the generator circuit breakers. The feeder circuit breakers are rated at 300 and 500 ampères, and will rupture 10,000 ampères at 15,000 volts. In the feeder reactors there is a drop of 3 per cent. of the voltage from phase wire to neutral when they are carrying the rated current. Their purpose is to reduce the shock on the system caused by line troubles, and to limit the current to the rated rupturing capacity of the oil circuit breakers.

* No. II. appeared April 20th.

On the switchboards in the operating room—shown in Fig. 17, page 448—the vertical sections for each generator contain the following instruments:—Three alternating current ammeters, an alternating current voltmeter, a polyphase indicating wattmeter, a power factor meter, a polyphase watt-hour meter, a direct-current field ammeter, and a temperature indicator. The swinging panel contains the synchroscope direct-current voltmeter for exciter and frequency indicators. The bench sections contain control switches for generator, sectionalising and oil circuit breakers and field and neutral switches, voltmeter receptacle, synchronising receptacles, main field and exciter field rheostat switches, bell alarm relay, temperature switch and receptacles, and signalling equipment.

Mimic bus-bars on these bench sections represent the main station wiring, and the arrangement of control switches conforms with that of oil circuit breakers and bus-bars in the station. The generator and feeder circuit breakers are so wired that they cannot be closed without the respective synchronising plugs being in their receptacles. The signalling equipment on the bench board is identical with that on the instrument panel at the turbine regulator or throttle valve. Since the switchboard and turbine operators are in separate rooms, provision is made for the use of signals in bringing machines up to speed and cutting them in or out of service. These signals include: "On," "off," "increase," "decrease," "hold," and "off quick." On the feeder switchboard there are three feeders per panel, each panel corresponding to a feeder group. The equipment for each feeder consists of three ammeters, one voltage indicating lamp, a synchronising receptacle, a pull-button control switch with red and green indicating lamps and three overload induction relays with test links. Two panels for the control of oil switch control circuits are placed at the end of the direct-current auxiliary switchboard. One of these is for the control battery, which consists of 60 cells in fifteen 4-cell trays. Two motor-generator sets of 15 kilowatts supply energy for the control system. The second panel is for the control of individual control circuits. A special feature of this system is that these circuits to different parts of the operating switchboard are supplied through separate switches in order to facilitate finding the seat of control circuit trouble.

STATION POWER AND LIGHTING.

The motor-driven equipment of the coal-crushing and pulverising plant is at some distance from the source of supply, and for this reason it was decided that such auxiliaries should operate at 480 volts. Direct-current auxiliary service is also provided on account of the crane in the turbine room, motor-operated valves, wagon-tipping machine, magnetic pulley on coal conveyor, and certain operations requiring variable speed. For this service 240-volt current was selected in order to make it available as an emergency source of excitation. To simplify this station power service, the control of main and emergency auxiliary feeders was put in charge of the switch-house operator, who handles it in the same way as a sub-station supplying a group of customers. All copper bus-bars, cables and wires are insulated, and safety switches have been provided at the various motors throughout the plant.

Service for alternating current auxiliaries is furnished by two water-cooled transformers, one of which is for reserve. They are 3000 k.V.A., 13,800–13,200-volt primary, 480-volt secondary, 60-cycle, three-phase machines. Bus-bars, transformer circuit breakers and oil circuit breakers on the feeders to distribution points are all in duplicate. There is one main feeder, and one emergency feeder to each main division of the plant, such as the coal crusher, coal pulverising building, boiler-room, engine-room and switch-house. Large air-break circuit breakers are used instead of oil circuit breakers on the secondary side of the auxiliary transformers. These breakers are provided with reverse power relays, so that with both transformers in service, trouble in one transformer or on its primary feeder will cause the proper breakers to open, thus clearing the trouble without interfering with the service.

For the direct-current auxiliary station power service there are two 300 kilowatts motor generator sets, one of them being in reserve. Each consists of a 480-volt, 60-cycle squirrel cage induction motor directly connected to a 250-volt direct-current, shunt-wound generator running at 1200 revolutions. These sets are supplied from the 480-volt alternating-current station supply service, but in order to guard against interruption a 150-cell storage battery is floating across the 240-volt direct-current bus. A circuit breaker is provided on each main feeder, and fuses on branch circuits. For economy in service the greater part of the lighting is supplied from the 480-volt alternating-current station power system, through transformers stepping down to 120–240 volts for three-wire distribution. Circuits in vitally important parts of the plant, however, have lamps connected two in series to the 240-volt direct-current station power system, since this battery insures against failure of this, as noted above. Certain other circuits can be connected to this direct-current system if necessary.

The lighting system is entirely independent of the power circuits, and the main distribution is controlled from a switchboard in the basement of the switch-house. In the turbine-room, holophane bowl refractors just below the plane of the roof trusses direct the light downward at an angle of 30 degrees below the horizontal, as it was desired to have the light diffused over the whole room without the use of side bracket or local lighting. This arrangement, with 500-watt lamps, lights up the machines effectively, and avoids any alternation of dark and light spots. An automatic telephone system, with a 50-circuit exchange, provides ready and economic communication between all parts of the plant.

At this Lakeside Station current is generated at 13,200 volts, three-phase, 60 cycles. All outgoing high-tension lines operate at 13,200 volts, and leave the station by underground conduits, although some of them rise at a short distance from the station in order to feed overhead lines. Many of these lines are connected to the various other city and suburban stations of the company, but some are connected to an outdoor transformer station, which steps the current up to 26,400 volts for transmission to points more than six miles distant. This transformer station has four 10,000 k.V.A., three-phase transformers. Eventually some portion of the current will be stepped up to 66,000 volts or more for transmission to greater distances.

The Milwaukee Electric Railway and Light Company operates about 250 miles of tramways and inter-urban electric railway lines, of which mileage more than half is double line. The company also carries on a general lighting and power business, supplying a large proportion of the current for city street lighting. It has four power stations in the city and two outside. There are eighteen sub-stations—three of which have automatic control—totalling 155,700 kilowatts capacity, 38 rotary converters, and 12 motor-generator sets. The rolling stock equipment comprises 750 motor passenger cars, 105 trailing cars, 10 motor goods cars, 12 trailing goods cars, 78 motor cars and 220 trailing cars for the company's service, six electric locomotives and 14 automobile passenger omnibuses.

The Control of Boilers by Temperature and Draught Measurements.

By JOHN B. C. KERSHAW, F.I.C.

THE use of CO_2 testing apparatus for determining the efficiency of boiler firing is now so general in all up-to-date large power plants, that there is a tendency to ignore the value of other tests and methods of arriving at the same knowledge. The object of the writer in this article is, first to direct attention to the interdependence of the test results for CO_2, temperature and draught; and then to describe some of the latest indicating and recording instruments, for making the latter type of measurements.

In many small steam-raising plants it is almost impossible to persuade the owners to provide the capital required for the first installation, or to find the labour for the charge and control of all three types of instrument. In such cases it is useful to know therefore, that temperature or draught measurements alone, if regularly taken and rightly interpreted, may serve as a very valuable guide to the efficient operation of the steam-raising plant.

THE INTERDEPENDENCE OF THE TEST RESULTS FOR CO_2 TEMPERATURE AND DRAUGHT.

Fig. 1 is an enlarged and simplified reproduction of a diagram, which appeared some years ago in the *Zeits. des Vereines deutsch. Ing.* It bears so directly upon the subject of this article that the author makes no apology for reproducing it here. The series of observations upon which the curves of the diagram are based, were carried out before the war, upon the steam-raising plant attached to the Technical School, at Brunswick in Germany. The boiler was of the water-tube type with 440 square feet of heating surface, and was operated at 300 lb. steam pressure. Fig. 2 is a sectional elevation of the boiler, and shows where the test-places for CO_2, temperature and draught were situated.

The waste gases were withdrawn from the combustion space at the point marked R, and were tested by the usual type of Orsat apparatus for their CO_2 contents. Temperature measurements were made at three points, namely, close behind the bridge wall at *g*; at the top of the first uptake of the boiler at *t*; and finally, at the exit from the boiler to the main chimney flue at *w*. The draught measurements were made similarly at *g* and *w*.

The six curves of the original diagram were constructed by plotting the results of all these tests during a ten hours' run of the boiler, during which the conditions were constantly changing between wide limits, as shown by the violent fluctuations of the temperatures taken behind the bridge wall. The temperatures at this point were taken by the Fischer calorimeter, which is based upon heating a block of iron of known weight to the temperature of the hot gases, and then dropping it into a measured volume of water, and noting the rise in temperature as the iron cools. The thermo-electric method was used for measurement

of the temperature at t and a mercury thermometer at w. The CO_2 tests ranged from 5 per cent. to 14 per cent., and the temperatures at the exit to the chimney, between 270 deg. and 380 deg. Cent. (518 deg. and 716 deg. Fah.).

When the curve for CO_2 and the three temperature curves are compared, however, they are seen to rise and fall in sympathy; the CO_2 curve rising as the temperature curves fall, and *vice versâ*. This signifies that the temperature of the combustion space, or of the waste gases, can be employed as a guide to the CO_2 contents of the same; and that the best results will be achieved when the temperature of

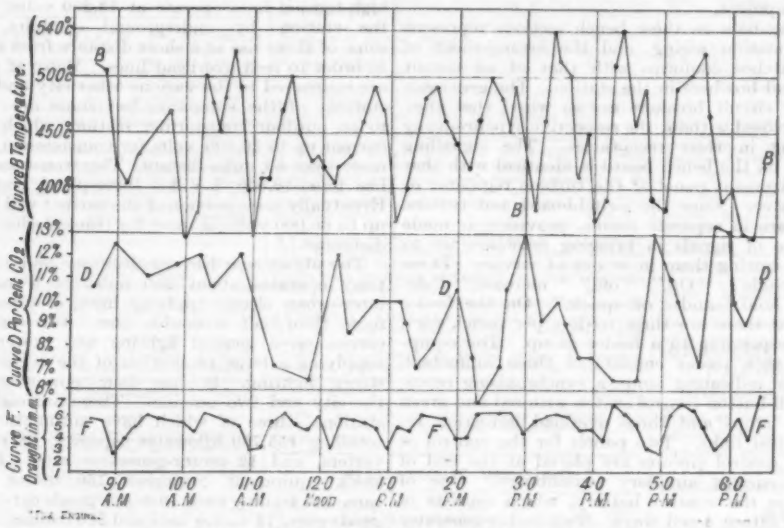


FIG. 1—CURVES OF DRAUGHT, CO_2 AND TEMPERATURE

these gases is kept as low as possible. Since the curves for the draught measurements also rise and fall in complete agreement with the temperature curves, one may also employ the record of the draught measurements, as a guide to the efficiency with which the boiler is being worked. The smaller the draught difference between the bridge wall and exit, the higher the CO_2 percentage in the exit gases, and the lower the heat losses will be.

This relationship between the draught and CO_2 will be more clearly understood if one realises the fact that the volume of air drawn in through or above the fuel on the grate is determined finally by the difference between the suction or pull of the chimney at these two points; and that the smaller this difference is, the smaller will be the volume of excess air passing

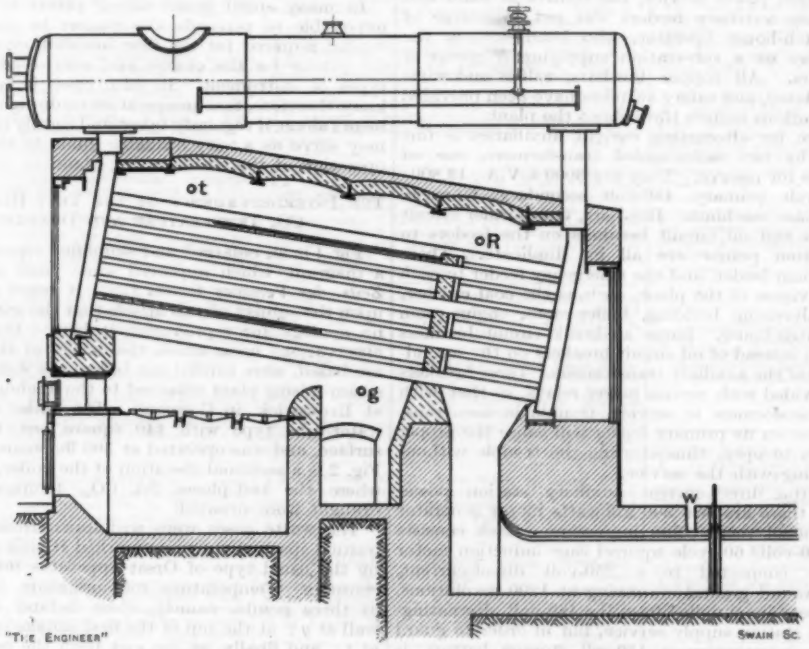


FIG. 2—WATER-TUBE BOILER USED IN MAKING THE OBSERVATIONS

through the flues of the boiler. The chief object of the stoker should therefore be to maintain the steam pressure with the minimum recording of a differential draught gauge, connected to the flues behind the bridge and at the exit to the chimney, since the smaller this reading is, the less will be the volume of gas and the lower the heat losses by the chimney.

It is necessary, however, when working boilers in this way, with only the temperature or draught measurements to guide one, to determine once for all by a series of exhaustive tests, what are the best maximum and minimum limits, at various rates of firing, for temperature and draught; since obviously these limits will vary considerably when the boiler is working at half, three-quarters, or its full steaming capacity. When these tests have been carried out, a table can be constructed which will indicate to the stoker and engineer in charge what temperature or draught must be maintained at each rate of firing, in order to obtain the highest efficiency.

As an example of such a table, that given in Maerck's article, for the boiler at the Brunswick Technical School may be quoted; but it must be understood that it is not applicable to other boilers, and that the only safe plan is to construct a similar table, based on the results of actual tests at half, three-quarters, and full load, for one's own steam plant.

Pounds of coal fired per hour per square foot of grate area	12½	14½	16½
Difference in draught between chimney and bridge, inch	.14	.19	.22
Temperature of boiler at t, deg. Fah.	788	878	968
Temperature at exit to chimney at w, deg. Fah.	536	609	680
CO_2 contents of waste gases at w, per cent.	13	10	10

With this particular boiler, it was impossible to maintain a higher rate of combustion than that represented by 16½ lb. of coal per square foot of grate area per hour, since the chimney draught was insufficient; but in most modern plants using fan draught, the rate of combustion is considerably higher than that indicated above. The principle, however, upon which this system of controlling the work of boilers is based remains the same, whether natural or artificial draught be employed; and either the draught or temperature measurements may be used as criterion of the efficiency, when once the preliminary tests have been carried out, and a table similar to the above has been constructed, for each unit of the steam raising plant.

Indicating and Recording Thermometers.

When the work of a boiler is to be controlled by temperature observations alone, it is necessary to have instruments installed which will indicate to the stoker at any moment, what the temperature of the combustion gases is, at the two points marked t and w on Fig. 2. The engineer ought also to have some independent check upon these results, and it is therefore advisable but not essential, to have also a recording instrument in use.

For temperature measurements up to 1000 deg. Fah. the Cambridge and Paul or Fournier distance thermometers are the most suitable, since they are reliable

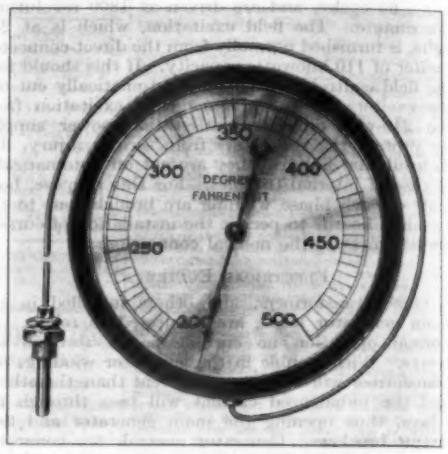


FIG. 3—C. & P. DISTANCE THERMOMETER (INDICATING)

and less likely to get out of order than the electrical type of instrument.

The Cambridge and Paul H. & M. distance thermometer consists of a steel bulb filled with mercury, connected by steel capillary tubing to a Bourbon pressure gauge of special design. The whole system is filled with mercury, and the pressure gauge can be placed at any distance from the bulb. The gauge can be provided with a dial face upon which the temperatures are marked plainly so that the fireman can have no difficulty in reading them while engaged in his ordinary duties. Fig. 3 shows the indicating thermometer made by this firm, and Fig. 4 the recording thermometer based on the same principle.

The other type of distance thermometer is based upon the same principle of measuring slight variations in pressure of a closed system; but in this case the pressure variations are dependent upon the pressure

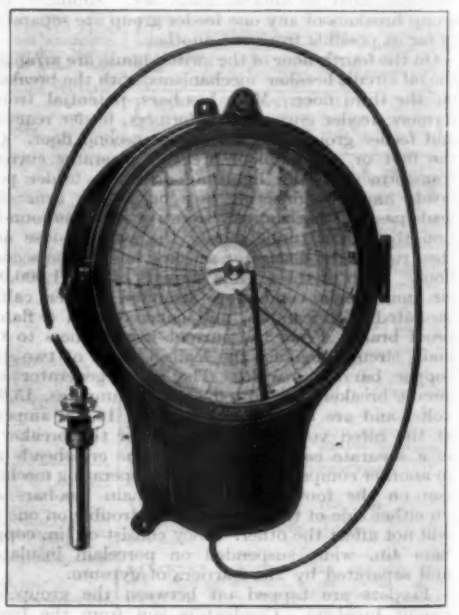


FIG. 4—C. & P. DISTANCE THERMOMETER (RECORDING)

of "saturated vapours," the quantities and combinations of which are kept secret by the manufacturers. The researches of M. Fournier, the French physicist, have proved that the tension of the saturated vapour is directly a function of the temperature and is quite independent of the volume occupied by the vapour. This being the case, the pressure within the bulb, and throughout the whole system, is constant for any known temperature, and changes only with the change of temperature surrounding the bulb. Distance thermometers constructed on this principle are being put on the market in this country by the Sarco Engineering Company, both an indicating and a recording thermometer being constructed of this type. Figs. 5 and 6 illustrate the Fournier

thermometers. Messrs. Alexander Wright and Co. have also placed on the market an indicating and recording pyrometer which is based upon the use of nitrogen in a closed system under high pressure—Fig. 7.

ELECTRICAL PYROMETERS.

If it should be considered desirable to make use of electrical methods for indicating and recording the temperatures of the combustion gases, two types of

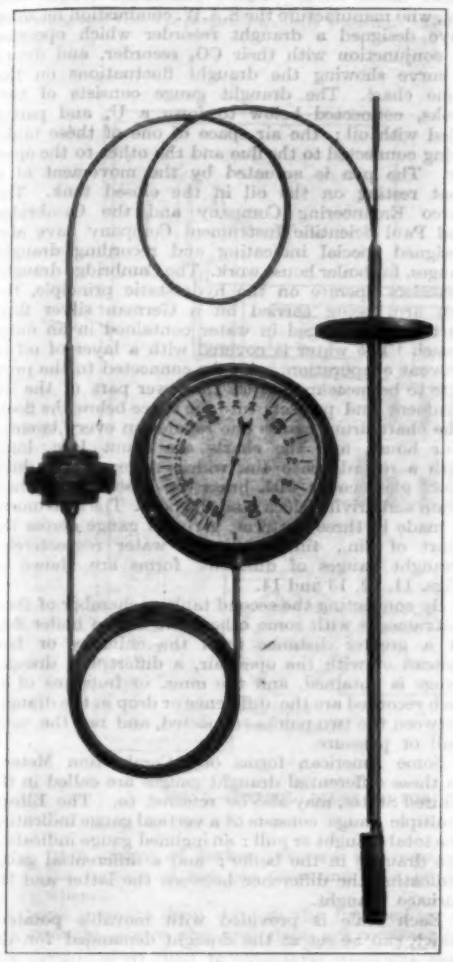


FIG. 5—SARCO (FOURNIER) DISTANCE THERMOMETER

instrument are available, one depending upon the changes in electrical resistance of a platinum wire when exposed to varying degrees of heat, and the other upon the electric current set up in thermo-couples on the application of heat. Both types of instrument involve the use of a galvanometer or Wheatstone bridge for measuring the current; and although the electrical type of instruments can be furnished with a scale giving direct readings of the temperature, they are not so suited to boiler house conditions as the pressure instruments described above.

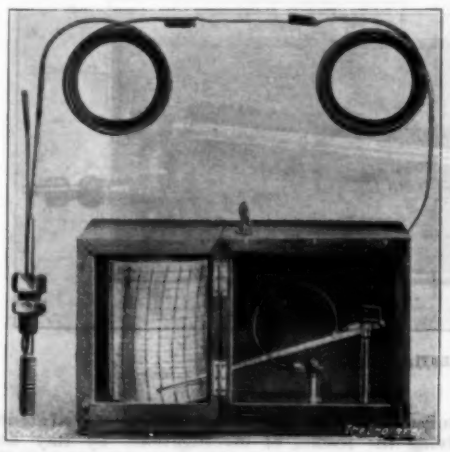


FIG. 6—SARCO (FOURNIER) DISTANCE THERMOMETER

The instruments in the construction of which platinum or platinum-rhodium alloys are used are also very expensive, while thermo-couples of base metal alloys are less durable and require more frequent calibration.

The chief advantages of the electrical pyrometers are that the temperature readings can be made at a very considerable distance from the point where the resistance wire or thermo-couple is inserted in the flue, and that any number of observation points can be connected to one indicating or recording instrument.

The Neasden power station of the Metropolitan Railway Company is equipped with a large number of thermo-electric pyrometers connected to one central

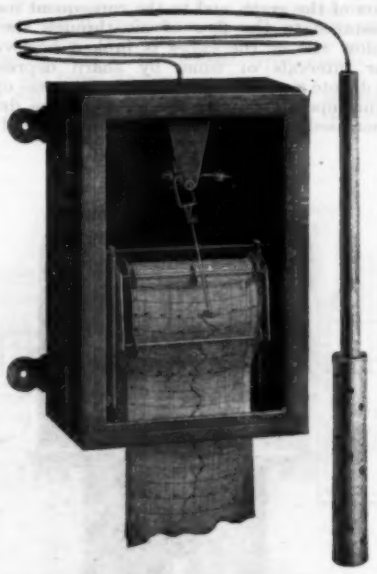


FIG. 7—WRIGHT INDICATING AND RECORDING PYROMETER

switchboard; and the engineer in charge of this plant can ascertain the temperature of the waste gases (or steam) at any point where these pyrometers are installed simply by inserting a plug is the particular hole in the switchboard for this connection, and by

FIG. 8—C. & P. ELECTRICAL RESISTANCE PYROMETER

then watching the movement of the finger over the scale of temperature readings. This installation of electrical testing apparatus was made by the Cambridge and Paul Instrument Company, but the Sarco Engineering Company and Messrs. Alexander Wright and Co. also specialise in the manufacture and installation of electrical pyrometers.

Fig. 8 shows the Cambridge and Paul type of indicating instrument for twelve points. In addition to numbered points corresponding to the thermometers, the instrument is provided with an "off," or disconnected position, and with another marked "Test." When the switch is in the latter position, the thermometers are all disconnected, but a resistance of known value is put in circuit. The indicator should then be deflected to the red line on the scale, and if this is not so, the necessary adjustment is made by means of a shunt. In this way it is possible to ensure that the instrument is giving correct readings, and to compensate for variation in the accumulator voltage, so that one accumulator which is contained in the case of the instrument, can be used for a long time.

Great care is necessary in the choice of positions for the thermometers or thermo-couples employed in measuring the temperature of the gases in boiler flues, for the errors caused by radiation are much larger than was at one time realised. The researches of Kreisinger and Barkley have shown that errors of from 5 to 25 per cent. in the readings are possible from this cause alone, and that the bulb exposed to the hot gases must be protected by some shield or petticoat of non-heat-conducting material, if correct readings are to be obtained. If the bulb is surrounded by tubes (or walls) at a lower temperature than the gases, it will give a low reading, for it will be radiating heat all the time to these cooler surfaces. It is most difficult, therefore, to obtain the correct temperature of combustion gases in the vicinity of the tubes of a water-tube boiler, or in the fire tube of a Lancashire boiler, unless the bulb of the thermometer or pyrometer is properly protected; and the probability is

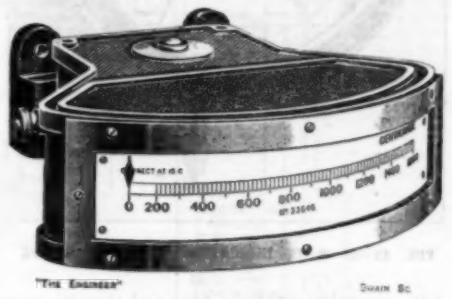


FIG. 10—SARCO INDICATING PYROMETER

that the temperature readings plotted in curves A and B of Maerck's chart, are all too low from this cause. This error, however, does not affect the value of the diagram, since its object is to show that the curves are synchronous, and rise and fall in sympathy with one another; and as the error of observation was a constant one, its magnitude makes no difference to the value of the chart. Under ordinary circumstances, however, it is important to have the temperatures correctly taken and recorded; and it is no use taking great care to calibrate electrical pyrometers, if equal care be not given to the choice of positions for them, in the boiler flues.

As regards the applications of temperature measurements and records in the control of steam boilers; they may first of all be used in lieu of CO_2 tests, to maintain a high efficiency of boiler working, when once the best temperature conditions at various points of the boiler flues have been ascertained by a complete series of tests over a considerable period of time.

The temperature figures given by Maerck for the water-tube boiler at the Brunswick Technical School, are all much lower than would be considered normal to-day, and the following represent what might be looked upon as average figures, for a hand-fired Lancashire type of boiler, burning a good bituminous fuel:—

	Deg. C.	Deg. F.
Temperature—		
In furnace	1535	2800
6ft. behind bridge	980	1800
In drop flue at end of fire tube	535	1000
At exit into main flue	340	630
At base of chimney (minimum)	150	300

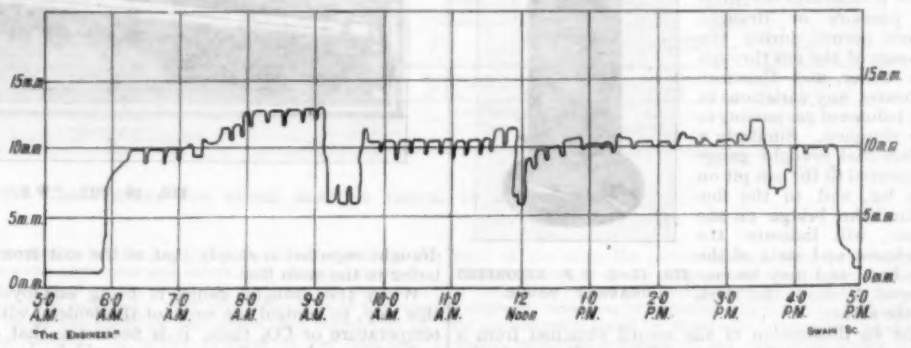


FIG. 9—DRAUGHT CHART FROM A FACTORY BOILER

When economisers are used for heating the feed-water of the boiler, the temperature is usually reduced by about 250 deg. Fah., and the waste gases pass from the economisers to the chimney at a temperature of 400 deg. to 450 deg. Fah. An exit gas temperature from the boiler flue (before entering the economiser)

above 650 deg. Fah., is indicative of bad work, and is a sign of dirty flues, an over-worked boiler, or of scale-covered boiler plates. When such a temperature is recorded for any boiler, its cause should be at once discovered, and, if possible, there should be no delay in remedying it.

Other deductions that can be made from the temperature records of the combustion gases, are the relative amounts of the losses due to soot and scale deposits; since the average readings after cleaning the boiler plates, or tubes, from these deposits will always be lower than before. The state of the fires,

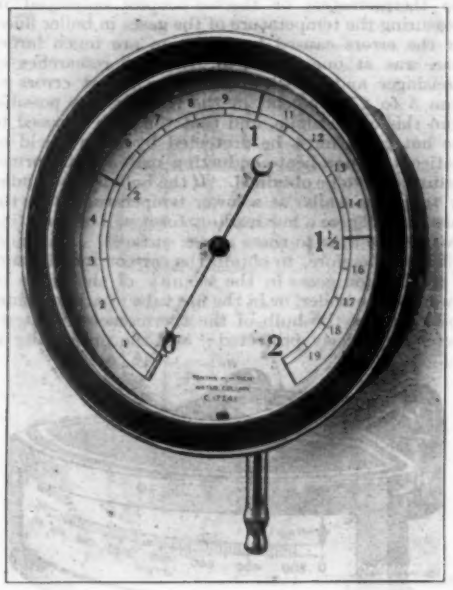


FIG. 11—C. & P. INDICATING DRAUGHT GAUGE

and the regularity of the stoking and cleaning operations can also be determined by a study of the fluctuations of the temperature curves, which thus serve as a check upon the work of the boiler fireman.

In fact, when an engineer has once learned to interpret and apply all the information given him by his daily chart of temperatures, he will be able to control the work of the boilers from his central office.

A point to remember is, that the straighter the temperature curve, and the nearer it approximates to what has been decided is the best working temperature for the boiler at a given rate of firing, the higher will be the efficiency.

INDICATING AND RECORDING DRAUGHT GAUGES.

The intimate connection that exists between draught, and the efficiency with which the boilers are being operated, has been referred to already in the introduction to this article; but owing to the importance of this relationship the matter may be referred to again, before describing the various forms of indicating and recording draught gauge now available for the boiler engineer.

FIG. 12—C. & P. RECORDING DRAUGHT GAUGE.

A differential draught gauge, one leg of which is connected to the flue behind the bridge, and the other to the flue before the damper which controls the exit into the main flue, acts as a "gas flow" meter, since it measures the drop in pressure or draught which occurs during the passage of the gas through the boiler, and therefore indicates any variations in the volume of gas passing to the chimney. Similarly a differential draught gauge connected to the ash pit on one leg, and to the flue behind the bridge on the other, will indicate the thickness and state of the fire bed, and may be employed to check the work of the stoker.

As an illustration of the record obtained from a draught gauge, that obtained from a factory boiler which was operated only during the day shift and was banked at night may be given—see Fig. 9—since it indicates the information which can be obtained from such a record, and shows how well it enables a check to be kept upon the work of the stoker.

The working hours of the factory served by this boiler were from 6.30 a.m. to 5 p.m. The draught record shows that at 5.30 a.m. the stoker came on duty, and opened the chimney damper to its full extent thus raising the draught from the 1 mm. that had been maintained on the boiler during the night to 10 mm. From 6.15 a.m. to 9 a.m. the draught curve is seen to maintain a steady but slow rise, due to the gradual accumulation of ash and clinker on the bars of the grate, and to the consequent increase of resistance to the flow of air through the fuel. This slow rise of the curve is broken however, at regular intervals of time, by sharp depressions, which denote that the door of the furnace was opened for firing operations. At 9 a.m. when the draught was increased to 12 mm. there is a sharper and more

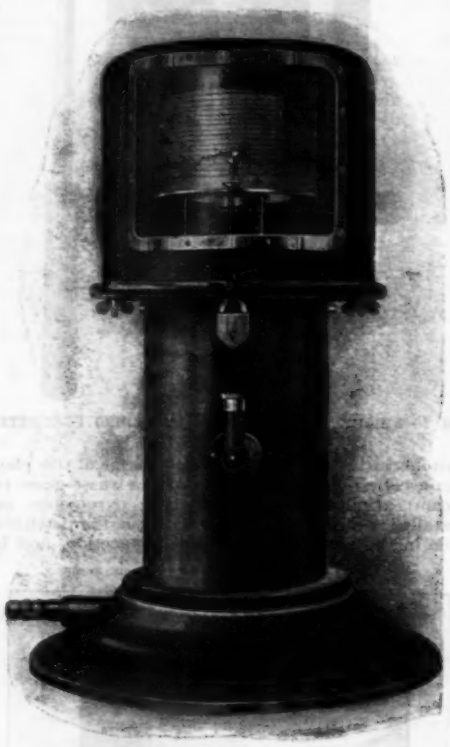


FIG. 13—SARCO RECORDING DRAUGHT GAUGE

prolonged depression in the curve, which signifies that cleaning the fires and removal of the clinker was in progress; and it is 9.40 before the effects of this have been overcome, and the draught has become stabilised again, at its proper level of 10 mm. At 12 a.m. and 3.30 p.m. the fires are again cleaned, and clinker is removed, with similar results upon the draught record; but in these cases the cleaning operations are of shorter duration than at 9 a.m., and the resultant effects upon the draught are not so serious or so prolonged. All through the day, however, the minor fluctations of the curve form a record of the stoker's attention to his duty of firing at regular intervals of time; and the chart thus serves not only as a check upon the work of the boiler, but also upon that of the activity of the man in charge of it. This boiler it must be noted was not provided with a differential draught gauge, and the draught recorded is simply that at the exit from the boiler to the main flue.

When the draught gauge is being employed in this way, to control the work of the boilers, without temperature or CO_2 tests, it is necessary that both indicating and recording gauges should be installed on each boiler; and that a gauge indicating the total draught at the base of the chimney, should be connected, so that the fireman in charge of the boilers may know exactly what reserve of draught he has to call upon, if any sudden demand for steam is made. When fan draught is installed, this knowledge is not so important; for the fan can always be run a little faster to increase the draught when required. The fact must not be overlooked that there is a speed limit beyond which it is uneconomical to run fans, and that in many cases increased draught can only be obtained economically, by substituting a larger fan.

Turning now to consider the various forms of recording draught gauge, all the firms who have designed and are now manufacturing CO_2 recorders, have given attention also to draught recorders, and there are several types which can be recommended for boiler house work. Messrs. Alexander Wright and Co., who manufacture the S.A.W. combustion recorder have designed a draught recorder which operates in conjunction with their CO_2 recorder, and draws a curve showing the draught fluctuations on the same chart. The draught gauge consists of two tanks, connected below to form a U, and partly filled with oil; the air space of one of these tanks being connected to the flue and the other to the open air. The pen is actuated by the movement of a float resting on the oil in the closed tank. The Sarco Engineering Company and the Cambridge and Paul Scientific Instrument Company have also designed special indicating and recording draught gauges, for boiler house work. The Cambridge draught recorders operate on the hydrostatic principle, the pen arm being carried on a German silver float partially submerged in water contained in an outer vessel. The water is covered with a layer of oil to prevent evaporation. A tube connected to the pressure to be measured enters the lower part of the instrument and projects into the space below the float. The chart drum makes one revolution every twenty-four hours, and the charts are about 13in. long, with a record space 4in. wide. A removable dust-proof glass cover with brass top protects the chart drum and driving clock, and the pen. The instrument is made in three patterns, giving a gauge across the chart of 2in., 4in. or 6in. of water respectively. Draught gauges of different forms are shown in Figs. 11, 12, 13 and 14.

By connecting the second tank or chamber of these instruments with some other part of the boiler flue, at a greater distance from the chimney or fan, instead of with the open air, a differential draught gauge is obtained, and the mms. or fractions of an inch recorded are the difference or drop in the draught between the two points connected, and not the total pull or pressure.

Some American forms of "Combustion Meter," as these differential draught gauges are called in the United States, may also be referred to. The Ellison multiple gauge consists of a vertical gauge indicating the total draught or pull; an inclined gauge indicating the draught in the boiler; and a differential gauge indicating the difference between the latter and the furnace draught.

Each scale is provided with movable pointers, which can be set at the draught demanded for the best efficiency attainable at half, three-quarter and full load. The gauges are all fixed on one board, where they can be seen easily by the fireman, without leaving the firing plate of the boiler.

The "Baily boiler meter" consists of a draught gauge of the recording type, combined with a steam flow meter; both enclosed in the same case and making a record on the same circular chart. The designer states that the amount of air required to produce a given amount of heat is practically the same for all forms of natural fuel, and that by comparison of the air flow with the steam flow, it is possible to attain maximum economy and to avoid losses by excess air and unburned gases.

In concluding this article some extracts from

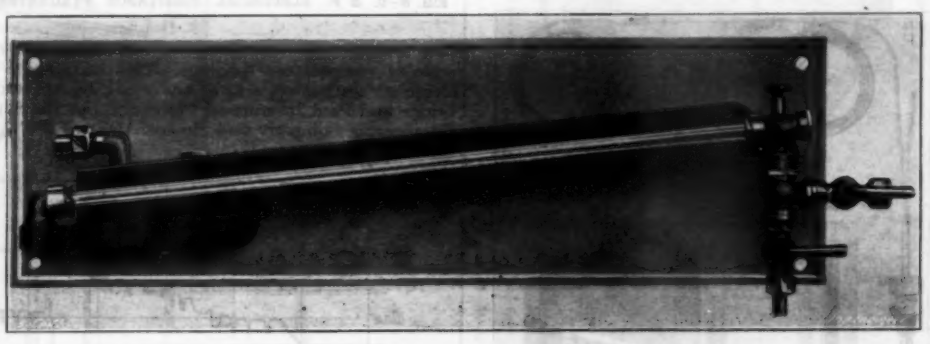


FIG. 14—THE "W.R." DIFFERENTIAL DRAUGHT GAUGE

Bulletin 367 of the U.S.A. Department of the Interior, giving the results of investigations by Ray and Kreisinger upon the significance of draught in boiler practice, may be given, since they have a very direct bearing upon the method of working boilers by draught records alone.

If the resistance to the flow of gas remains unchanged, the pressure drop through any portion of the gas passage bears a constant ratio to the total pressure drop.

If the total pressure drop from ash pit to uptake remains constant, the pressure drop through any portion of the gas passage varies with the resistance to the flow of gas through that particular portion.

If the resistance of any portion of the gas passage remains constant, the weight of gas passing through that portion varies as some power of the pressure drop through it. The index of the power is approximately 2, so that in order to double the weight of gas passing through, the pressure drop must be quadrupled; and in order to treble it the pressure drop must be made nine times as great.

There is really no difference between "forced" and "induced" draught, provided the setting is tight. The volumetric percentage of "dead" corners in a boiler is the same in either case.

With gases there is no pulling, only pushing. Gases travel from places of higher pressure to those of lower, the motion of the gas occurring because of its expansion.

A large pressure drop through the fuel bed (or a high draught above the fire) does not necessarily mean that the rate of combustion is high; it is likely to mean the opposite. High pressure drop through the fuel bed always means high resistance in it to the flow of gas. The pressure drop through the fuel bed, or the draught over the fire, is significant only when considered in connection with the total pressure drop.

The capacity of a boiler increases with the difference between the pressures in the uptake and over the fire. With constant total pressure drop (total draught) the capacity of a boiler decreases as the pressure drop through the fuel bed increases.

A NEW YORK cable announces the sudden death of Mr. Stuyvesant Fish, for many years the president of the Illinois Central Railway and the chairman of the American Railway Association when the seventh session of the International Railway Congress was held in Washington in May, 1907, and, therefore, the acting president of the latter.

Electric Transmission of Power for Propelling Machinery.*

By W. J. BELSEY.

THIS paper deals with the application of electricity as a means of transmitting power from the prime mover to the propeller, and the remarks made will generally apply to merchant ships. Electrical systems for ship propulsion may be classified in two general types, namely, turbo electric and Diesel electric.

The self-starting synchronous motor is mechanically ideal for sea conditions. It is rugged in construction, highly efficient, and has a large air gap. All the windings are accessible, and all repairs, if such are necessary, even to a complete rewind, can be carried out with the motor in position, and it normally operates at unity power factor, thereby reducing the size of the main generator. The diagram—Fig. 1—shows the electrical connections between the turbo alternator and motor, and also the arrangement for controlling the direct-current exciting current on the field windings of both machines. When starting up the propeller motor from rest, it functions as a squirrel-cage induction motor with the direct-current field winding unexcited.

The sequence of switching is as follows:—With the cam shaft, which is operated by chain gearing from an oil pressure motor, on the stop point the main power circuit and also the alternator and motor field circuits, are open. The exciter is, of course, running at a voltage corresponding ing to normal full load. The first movement of the cam shaft closes the ahead or the astern line contactors as may be desired. A further rotation of the cam shaft closes the alternator field contactor.

This causes the motor to rotate as a squirrel-cage induction motor, and as the speed approaches the synchronous speed of the alternator, as shown on a speed indicator fitted in front of the operator, the cam shaft is rotated through a further angular movement, which causes the motor field contactor cams to close the respective contactors and introduce the direct-current field on the rotor of the motor. Due to the type and special characteristic given to the squirrel-cage winding, the motor pulls into synchronism very quickly.

During the above switching period, the turbine governor is set to a very low speed—approximately 10 per cent. of maximum speed—and the governor speed adjusting mechanism is interconnected with the cam shaft, so that any further rotation of the same merely increases the governor speed setting while maintaining the previously closed contactors in the closed positions.

When stopping, the cam shaft is returned to the stop position by means of the oil pressure motor and the sequence of switching operations carried out in the reverse way. If a propeller reversal is required, the cam shaft is rotated past the stop point until the motor is connected up as an induction machine with reversed phase rotation.

When this point is reached, the following are the conditions of affairs:—Turbine speed governor set to 10 per cent. speed. Motor connected as induction motor—i.e., without direct-current field. Alternator field excited from direct-current exciter.

Under the above condition the turbo alternator speed is rapidly falling, due to the steam being cut off by the action of the governor, and in the meantime the propeller motor speed is also rapidly falling, due to the effect of the reversed phase rotation on the squirrel-cage winding. Depending very largely on the propeller characteristic and the original speed of the ship, the motor reaches zero speed either before or after the steam is again admitted to the turbine by the action of the governor, but in any case the motor changes its direction of rotation and rapidly approaches the synchronous speed of the turbo alternator, when a further backward rotation of the cam shaft closes the motor direct-current field contactor and the machines pull into synchronism.

In order to enable the operator to find the synchronous speed quickly, irrespective of the alternator frequency, the speed indicator is fitted with two elements, each moving a pointer over a common scale. One pointer indicates motor revolutions per minute, and the second pointer indicates alternator revolutions per minute. The result is that when the two pointers are in line on any portion

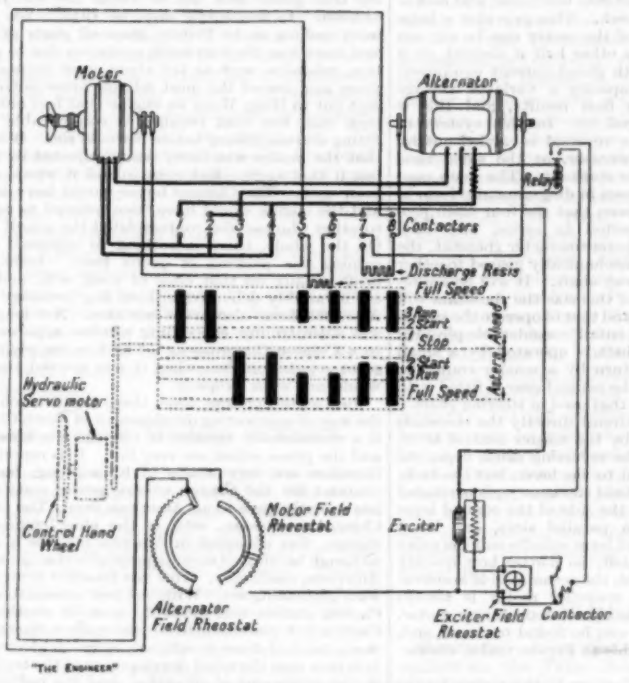


FIG. 1—CONTROL DIAGRAM FOR SYNCHRONOUS MOTOR

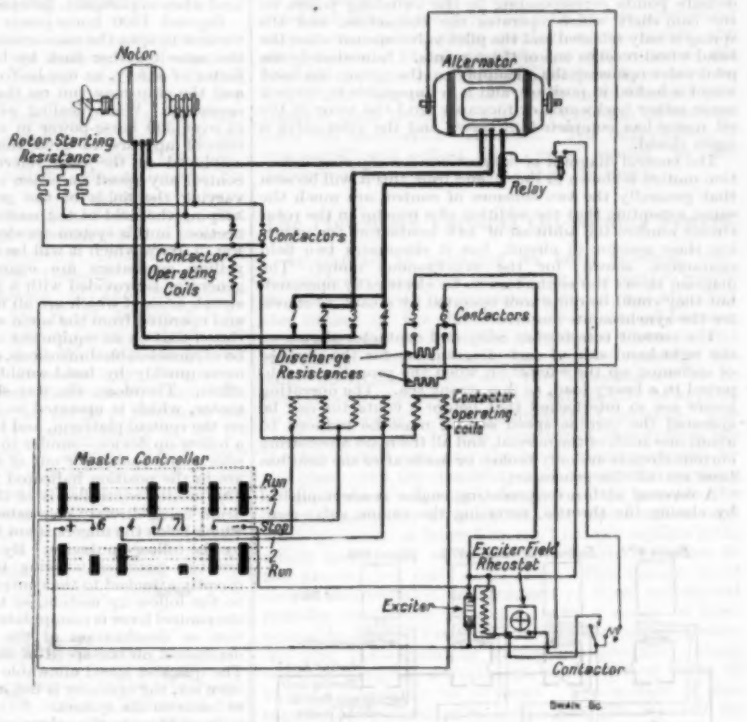
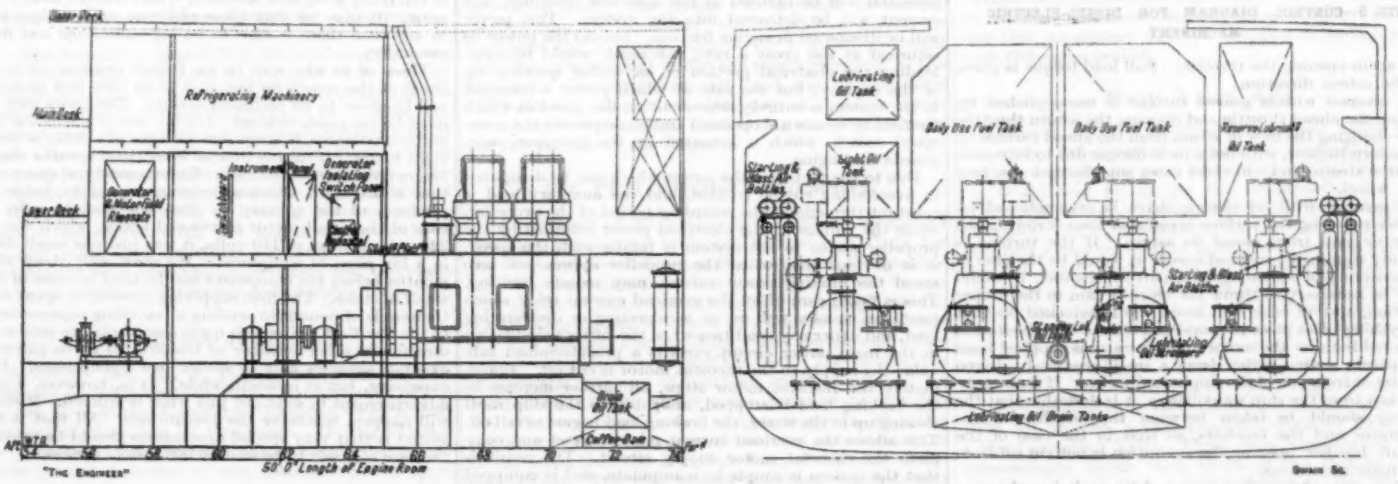


FIG. 2—CONTROL DIAGRAM FOR INDUCTION MOTOR



FIGS. 3 AND 4—MACHINERY ARRANGEMENT FOR DIESEL ELECTRIC VESSEL OF 2500-S.H.P.

* Abstract of paper read before the Institution of Engineers and Shipbuilders in Scotland, April 10th.

of the scale the machines are in synchronism.

If the machines have been synchronised before the fly-wheel energy in the turbine and alternator rotors has been dissipated—*i.e.*, at speeds above 10 per cent. and before steam is again admitted to the turbine—the propeller motor will begin to slow down again until the 10 per cent. speed is reached, but if the cam shaft is rotated over the speed points beyond the synchronising point, steam is again admitted and a rapid reversal of the propeller and stopping of the ship can be obtained.

The oil pressure motor which rotates the cam shaft is a development of the well-known servo motor commonly used for controlling the steam admission to a turbine through the agency of a centrifugal governor.

The pilot valve is operated by means of a spring, which in turn is loaded up when the large hand wheel is rotated. The spring can only operate the pilot valve at certain definite points corresponding to the switching points on the cam shaft which operates the contactors, and the spring is only released and the pilot valve opened when the hand wheel reaches one of these points. Immediately the pilot valve opens up the oil supply to the motor, the hand wheel is locked in position, and it is impossible to move it again either backwards or forwards until the rotor in the oil motor has completed its travel and the pilot valve is again closed.

The control diagram of connections for slip-ring induction motors is shown in Fig. 2, and from this it will be seen that generally the two schemes of control are much the same, excepting that the addition of a resistor in the rotor circuit renders the addition of two contactors for inserting their resistor in circuit, but it eliminates two field contactors shown for the synchronous motor. The diagram shows the contactors to be electrically operated, but they could be quite well operated by a cam, as shown for the synchronous motor.

The current transformer relay and contactor shown on the right-hand side of each diagram are for the purpose of stiffening up the excitation when the propeller is subjected to a heavy load, as in a strong sea. The operating levers are so interlocked that before a contactor can be operated the turbine speed setting must be reduced to about one-sixth of the normal, and all the main alternating current circuits are only broken or made after the field has been cut off the generators.

A reversal with a reciprocating engine is accomplished by closing the throttle, reversing the engine valve-gear,

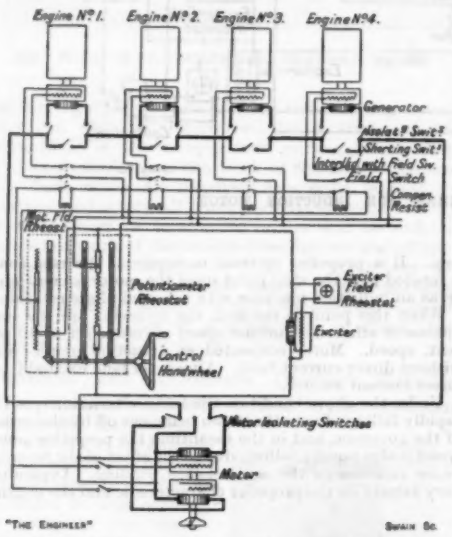


FIG. 5—CONTROL DIAGRAM FOR DIESEL-ELECTRIC MACHINERY

and again opening the throttle. Full load torque is given in the astern direction.

A reversal with a geared turbine is accomplished by closing the ahead throttle and opening the astern throttle, thus changing the flow of steam from the ahead turbine to the astern turbine, with not a little danger due to introducing live steam, and—in some cases superheated—on to a cold wheel.

A reversal with an electric drive is accomplished by merely reducing the turbine speed and then throwing the lever or cam from ahead to astern. If the turbine is already running at reduced speed, as would be the case in manœuvring or steaming in a narrow channel, it would only be necessary to throw the lever or cam to the proper position, and all cams and levers are interlocked, so that everything takes place in proper sequence. The excitation required both for the motor and generator is supplied from a separate source, either from a small separately driven exciter or from one of the ship's auxiliaries. If the supply is taken from the ship's auxiliaries, it is desirable that the supply should be taken between the brushes of the generator and the bus-bars, so that in the case of the circuit breaker opening the excitation is not cut off from the main generators.

The writer claims that electrical transmission of power for propelling purposes, for 3000 horse-power upwards per propeller, is a little more economical than single-reduction gearing, and is decidedly more economical than double-reduction gearing, and also is more economical than the old-fashioned reciprocating machinery. The author shows in tabular form the losses for a typical 14,000 shaft horse-power equipment with single and double-reduction gears and turbo electric drive, assuming the water rate at the turbine shaft is 100 in all cases.

The method of propulsion has been comparatively little used up to the present, and has been confined to comparatively small ships of from 400 to 800 shaft horse-power. There are, however, three merchant ships of 3000 horse-power building at the present moment in the country which are being fitted with this type of propelling equipment. Obviously alternating current is the most suitable for turbo electric drive, but for a Diesel electric drive for smaller powers direct-current is attractive, principally on account of greater flexibility allowing constant speed of the engine irrespective of the speed of the propeller.

Following is a description of the equipment now being made. The machinery arrangement is shown in Figs. 3 and 4. Each equipment consists of four 750 brake horse-power Fullagar-Diesel engines running at 250 revolutions per minute, each direct coupled to a 500-kilowatt 220-volt main generator and a 200-kilowatt 220-volt auxiliary generator. The main generators are connected in series, and drive a double unit 2500 horse-power motor, running at 90 revolutions per minute, direct coupled to the propeller shaft. The auxiliary load when all the refrigerating plant and the hold fans and auxiliaries are running amounts to over 500 horse-power. The connections are so arranged that any of the main generators can be used for auxiliary load when in port, say, for operating the cargo winches, &c.

Beyond 1500 horse-power it is generally more convenient to split the main motor into two units, and couple the same together back by back. This provides a large factor of safety, as one-half of the motor can be cut out and the ship may run on the other half if desired, or if necessary. When dealing with direct-current equipment of over 500 horse-power in capacity a variable voltage control appears to give the best results, and this is employed in the case referred to. In this system of control any speed variation or reversal is carried out by varying the fields of the generator, at the same time keeping the field of the motor constant. The main connections in this system are shown in diagrammatic form in Fig. 5, from which it will be seen that the four main propelling generators are connected in series, and each generator is provided with a potentionmeter rheostat, the switch arms of which are all mechanically geared together and operated from the same way-shaft. It will be appreciated that on an equipment of this size the rheostats will be of considerable dimensions, and that to operate the switch arms quickly by hand would entail considerable physical effort. Therefore, the way-shaft is operated by a small motor, which is operated in turn by a master controller on the control platform, and the control gear is fitted with a follow-up device—similar to that used in steering gears—which cuts the motor out of circuit directly the rheostats are in the position indicated by the master control lever. The master controller is of the reversing drum type, the drum being directly connected to the lever, but the body which holds the fingers is not held stationary; it is rotated by the follow-up device. By the side of the control lever are two pointers working in parallel slots, one being directly attached to the control lever spindle and the other to the follow-up motion, so that, no matter how quickly the control lever is manipulated, the actual rate of acceleration or deceleration of the propeller motor is always dependent on the speed of the rheostat operating motor. The quickest speed allowable can be found on trials, and, once set, the operator is not able to impose undue stresses or loads on the system.

In addition to the safeguards given to the system by the fixed speed of the rheostat motor, further protection is afforded by an overload relay and a speed limiting switch on the engines. The overhead relay is fitted in the main power circuit, and whenever the current exceeds a predetermined value, either when accelerating or decelerating ahead or astern, it immediately interrupts the supply to the rheostat motor, and prevents the operator increasing the current beyond this point. It is so arranged, however, that if the relay interrupts the rheostat motor supply, on an accelerating load, a movement of the control lever back towards the stop point automatically resets the relay and allows of a reduction in propeller speed being made. The overspeed switch is actuated by the engine governor, and is arranged to interrupt the power supply to the rheostat motor whenever the engine speed causes the fuel supply to be entirely cut off.

If power is cut off from the propeller motor, it will continue to evolve in a forward direction due to the way on the ship. Therefore, if the motor fields are excited, a potential will be induced in the armature windings, and current will be delivered into the system. This power will be dissipated in engine friction. Should the power be returned at too great a rate, the result would be overloading the electrical portion or an undue speeding up of the engines; but the rate at which power is returned to the system is entirely dependent on the speed at which the field rheostats are operated and consequently the overspeed switch, which is actuated by the governor, safeguards the engine.

Due to the fact that the power which can be dissipated in overcoming engine friction, and the auxiliary load is constant throughout the retarding period of the propeller, while the voltage of the electrical power returned by the propeller motor to the system is falling with the speed, it is obvious that when the propeller approaches zero speed the braking power current may require limiting. This is taken care of by the overload current relay which functions equally well on an accelerating or decelerating load, and under any condition when the current circulating in the main power circuit exceeds a predetermined safe value the supply to the rheostat motor is cut off. Immediately the rheostat motor stops, all further increase in the braking load is stopped, and, due to the ship itself slowing up in the water, the braking load begins to fall off. This allows the overload current relay to reset and complete the rheostat motor supply circuit. The result is that the system is simple to manipulate, and is equipped with all the safeguards necessary to prevent the operator abusing the equipment when manœuvring. Overload trips and similar electrical devices are not provided, it being considered undesirable to allow of the possibility of a sudden total interruption to the power supply such as might conceivably occur when manœuvring.

Packing and Despatching.

(Contributed.)

It is remarkable that firms of great repute in Great Britain should be careless about technical details in connection with their export trade. For many years the writer has had the opportunity of seeing a most varied assortment of British machinery arrive in South China. In nearly all cases the goods came up to expectations. The actual workmanship has invariably been excellent. There are, however, exceptions. Some months ago, when a small electric motor was unpacked, it was found that the voltage, which had been most carefully specified in the original order, was just double that requested. As the motor was for direct-current working the only thing that could be done was to write to England at once and request replacement. A most irritating delay of three months resulted. If that motor had been delivered to a Chinese client he would have probably said nothing about its defects, but would have said a good deal about the unreliability of British goods. It is only right and proper to say that in nearly all cases there is good supervision in packing, but during last year three mistakes came to the writer's notice. The only reason for mentioning the subject now is to beg, most sincerely, that British engineering firms will take every precaution to see that goods sent out to China are really the goods ordered. In the hectic days of 1919, when the orders were rushing in to Britain from all parts of the world, and there was the inevitable confusion due to re-organisation, mistakes such as the above were excusable. Many years ago, one of the most reliable firms in Great Britain sent out to Hong Kong an engine that had not only never been run, but that required a considerable amount of fitting and machining before it would run. It so happened that the matter was fairly easily adjusted in this Colony, but if that engine had gone inland it would never have been used. The Chinese buyer would have laid it aside and the engine would have been pointed to as a warning to other Chinese who contemplated the use of machinery. On the whole, there is nothing to complain about concerning the packing of goods from "home." British firms usually do that class of work well, and the goods are invariably delivered without any breakage or damage. American firms also make mistakes. Not long ago, there was some trouble concerning wireless apparatus supplied to a Chinese Government. The firm supplying it had a great reputation, but when it was erected the apparatus would not work properly.

Just at the present time, there is not much activity in the way of engineering development in South China. There is a considerable amount of German machinery for sale, and the prices asked are very low. It is reported that the Germans are very active in Kwangtung, but the large contract for the Canton electric power station extension has recently gone to an American firm. The fact that the Chinese gentleman, who is the chief engineer at that station, was educated in America may be a coincidence, although he himself is quite emphatic that he will only use American machinery. This last contract is for a 5000-kilowatt generating set. With the new extension of plant the Canton station will probably soon be overloaded again. Canton is a more industrial centre than Shanghai, and in due course of time it will use as much electrical energy. It is true that the rapid development of the textile industry in the settlement at Shanghai, and the political chaos in Canton, have enabled Shanghai to get a good start in adopting modern methods of industry. The result is almost incredible, viz., that Shanghai uses about twice as much electrical energy as does Liverpool. When once Canton is able to have a secure and stable government, there should be industrial revolution from the old handicraft style to the modern factory, with the demand for electric power and machinery. There is also the certainty of a big increase in the demand for electrical energy in Hong Kong and Kowloon. If the handling of cargo is reorganised and the local wharves are electrically equipped, there should be some substantial orders for British firms. There is some talk of an amalgamation of interests and a general reorganisation, arising out of the schemes for the improvement of the port facilities. The firm of Alfred Holt and Co., Limited—Blue Funnel Line—has splendid wharves and go-downs of their own. The Canadian-Pacific Ocean Steamship Company, Limited, Indo-China, P. and O., and other lines use the wharves and go-downs of the Hong Kong and Kowloon Wharf and Go-down Company. It may be that these concerns will amalgamate; in any case there is sure to be big extensions and more machinery.

Those of us who wish to see British firms secure a full share of the orders do beg that great care and attention will be given to all technical details. The goods sent out must be the goods ordered. If a fan motor is sent out here and is unsuitable, it is not just a matter of a delay of forty-eight hours. It means that at least three months elapses before errors can be rectified. Unfortunately, it also means that a disgusted Chinese customer is apt to judge the products of the country by that one mistake. In the case of the small motor mentioned above, which was for 220 volts instead of 110 volts, it was just one small detail in a big piece of equipment. We must wait about three months before the equipment can be used because of that small mistake. The firm supplying it recently spent some thousands of pounds in sending a travelling representative to the Far East. Now it is quite a good plan to send out a director or other member of the firm so as to galvanise existing agencies and to secure new connections. It is expensive, but it is worth while. It is, however, a good advertisement to send out just what is ordered. Mistakes will happen, whatever the precautions. All that is suggested is that very special precautions should be taken in the case of goods to be sent 10,000 miles overseas.

Regret is expressed in the *Great Western Railway Magazine* for April that the company's excellent record of only 39 servants killed and 1619 injured during 1921 has been followed by 44 being killed and 2217 injured during 1922. It is explained, though, that six of the fatal cases and 324 of the non-fatal occurred on lines that were absorbed last year. Other companies, will, we expect, have the same disagreeable experience. The Great Western people attribute the better results for last year to the three months' coal stoppage, but as we had occasion to point out on July 21st last, traffic was slack during the whole of 1921. Men could, therefore, take their time and there were fewer accidents. In 1914, when the "safety" movement was started on the Great Western, the non-fatal cases numbered 3375.

A Seven-Day Journal.

The Einstein Theory.

It may be recalled that the expedition sent out by Greenwich Observatory to Christmas Island for the purpose of observing the solar eclipse of September 21st last met with disappointment, the weather suddenly breaking on the morning of the eclipse, and no photographs were secured. At Wallal, on the north-west coast of Australia, where expeditions from Canada and the Lick Observatory were stationed, the conditions, on the other hand, were excellent. It now appears that, according to Professor Chant, of Toronto University, the analysis of the results secured by the Canadians indicates partially but not decisively the accuracy of the Einstein theory. In the case of four stars near the sun the displacements as measured on the plates ranged from $^1/_{1500}$in. to $^1/_{5000}$in. The Lick Observatory results, according to Dr. Campbell, the Director, definitely confirm the theory of relativity. Five results for the bending of stellar rays just grazing the sun show an average value of 1.74 seconds of arc, the minimum being 1.59 seconds and the maximum 1.86 seconds. These values are stated to be in as close agreement with those calculated from the theory of relativity as the most ardent proponent of that theory could wish. But agreement in the mere value of the shift does not confirm the theory. There must also be agreement in the direction of the shift; and on this point we are as yet without information.

Professor Magnus Maclean to Retire.

At the opening of an exhibition held at the Royal Technical College, Glasgow, on Saturday, Mr. James Mackenzie said that under the age limit rule of the Scottish Education Department, the College would shortly be deprived of the services of one of its oldest and best professors, Dr. Magnus Maclean. Trained under Lord Kelvin, whose assistant he was for many years, Professor Maclean retires from the Chair of Electrical Engineering after fully twenty-four years of teaching service. His work is appreciated not alone by the many electrical engineers who count themselves among his past students, but by all associated with the electrical industry in Scotland. A valued member of the Scottish Section of the Institution of Electrical Engineers, Dr. Maclean has done much to promote the welfare of the Institution, and last year he lectured at the Summer Meetings on the hydro-electric resources of the Highlands, a subject to which he has in recent years devoted great attention. We learn that the Governors of the College have appointed Dr. Stanley Parker Smith, Assistant Professor in the Electrical Department of the City and Guilds Engineering College, South Kensington, as successor to Professor Maclean. Dr. Smith goes to Glasgow with high academic credentials, and a wide practical knowledge of the electrical engineering industry in its varied branches, and we wish him success in his new sphere of work.

The Hoffmann Manufacturing Company.

In our Journal of March 2nd we intimated that the Government was prepared to receive offers for the purchase outright of its entire holding of shares in the Hoffmann Manufacturing Company. It is now announced that the tender jointly made by the United Steel Companies, Limited, and the Parent Tyre Company has been accepted by the Government. The Hoffmann Manufacturing Company was established in 1900, and it occupies a leading position in the industry connected with the manufacture both of ball and roller type bearings. During the war, the Government took over the undertaking and the plant and works at Chelmsford were considerably extended.

Mr. Clynes at Stanton.

On Friday last Mr. J. R. Clynes performed the ceremony of relighting the four blast-furnaces of the Stanton Ironworks Company, Limited, which had been out of operation for two years. During the last few years the company has made notable developments in the direction of the manufacture of spun concrete, concrete-lined iron pipes, and spun iron pipes, involving extensive new plant, and the re-starting of the furnaces in question marks a return to practically normal industrial conditions. In addressing the workpeople, Mr. Clynes referred to the excellent relations which have so long prevailed between masters and men at Stanton and the harmonious spirit which existed between the management and the men in the works. The trouble in industry, he said, was all about sharing out the products of the labour of hand and brain. He did not begrudge the real captains of industry the best reward to which their services entitled them. The men who directed, the men who invented and produced schemes whereby alone manual work was possible, deserved the best reward in both pay and honour, and all that the working man asked from them in exchange was that they should see to it that too much of the reward of industry should not go to that form of capital which was idle and useless as far as the general direction and expansion of trade were concerned. Further, they should see that manual work received its due reward.

The Broadcasting Inquiry.

Following the discussion and correspondence which has arisen out of the difference of opinion between the Postmaster-General and the British Broadcasting Company, concerning the question of a new form of licence, it is announced that the Postmaster has appointed a Committee to deal with the question of broadcasting in all its aspects. The chairman of the Committee will be Major-General Sir Frederick Sykes, and the following members have been nominated:—Major the Hon. J. J. Astor; Mr. F. J. Brown, the Assistant Secretary of the General Post Office; Sir Henry Burbury, Comptroller and Accountant-General of the General Post Office; Viscount Burnham, chairman of the Newspaper Proprietors' Association; Dr. W. H. Eccles, F.R.S., President of the Radio Society of Great Britain; Sir Henry Norman, Bart.; Mr. J. C. W. Reith, the general manager of the British Broadcasting Company; Field-Marshal Sir William Robertson; and Mr. Charles Trevelyan. Under the terms of reference the Committee will consider (1) broadcasting in all its aspects; (2) the contracts or licences which have been or may be granted; (3) the action which should be taken upon the determination of the existing licence of the Broadcasting Company; (4) the uses to which broadcasting may be put; (5) the restrictions which may need to be placed upon its use or development. All communications should be addressed to the secretary, Broadcasting Committee, General Post Office, E.C.

The Shipbuilding Crisis.

Resulting from the continued strike of boilermakers in the Tyne district and the failure of the boilermakers', joiners' and plumbers' unions to honour the national overtime and night-shift agreement made by the Engineering and Shipbuilding Trade Unions' Federation with the Shipbuilding Employers' Federation on March 22nd, lock-out notices were posted against the members of these three unions on Monday last. The notices stated "that on and after Monday, April 30th, 1923, employment will not be available in federated establishments to members of the United Society of Boilermakers and Iron and Steel Shipbuilders, the Amalgamated Society of Woodworkers, and the United Operative Plumbers' and Domestic Engineers' Association of Great Britain and Ireland, unless intimation is received from the Federation of Engineering and Shipbuilding Trades prior to that date that these societies are prepared to accept the agreement. At a conference of the Federation held on Tuesday last, efforts were made to induce the three unions to accept the terms. As a result of further negotiations on Thursday, the employers agreed to postpone the lock-out notices for a week, provided that the men worked under the new agreement in the interval. Discussion ensued, and the boilermakers still held out. Later the Ministry of Labour intervened, and Sir Montagu Barlow expressed a desire to see the parties to the dispute.

The First Electric Locomotive.

In our issue of November 7th, 1890, we described the first locomotive built by Mather and Platt for the City and South London Railway. On Wednesday last this engine made its last journey from the Stockwell depôt of the company to the Science Museum, South Kensington, where it will take its place alongside the Rocket, Puffing Billy, Sans Pareil, and other famous steam locomotives of the past. The locomotive in question was one of fourteen engines supplied by Mather and Platt, which were designed to develop 100 effective horse-power at speeds up to 26 miles per hour. The armatures of the two motors were so constructed that the armature formed the axle of the locomotive. The two motors were not coupled, and each axle worked independently. The City and South London line is the only tube railway upon which electric locomotives are still in use, and these will disappear when the reconstructed line is opened towards the end of the present year.

Speeding Up American Mails.

We understand that considerable dissatisfaction has been expressed of late, both in London and New York, concerning delays in the delivery of Transatlantic mails, and that the matter is one which is having the consideration of the General Post Office. According to some accounts, matters are made worse by both postal authorities discriminating in favour of ships of their own nationality. It is pointed out that the Olympic sailed from New York a few Fridays ago with scarcely any mails, on account of an American ship which was sailing the following day. There was a difference of three days in the scheduled time of crossing for the two ships, and thus four days were lost. On the other hand, practically all outgoing mails are sent by Cunard ships, which are the fastest on the direct service route. Another factor is the rapid handling of mails on this side, and an interesting experiment takes place to-day when, under the auspices of the Plymouth Chamber of Commerce, the Instone Air Line has agreed to send an Avro machine which will pick up dummy mails in the Sound and transfer them from Plymouth to Croydon to connect with the continental air mails. The experiment, if successful, will effect four days' saving in the delivery of American mails to the Continent.

The Hutchison Turbinia Oil-burning System.

According to accounts we have received, considerable saving in fuel, amounting, it is said, to nearly 20 per cent., with an increase in speed, has attended the fitting of the Hutchison Turbinia oil-burning system to the two Anchor liners, the Circassia and the Castila. We learn that two further vessels of the same fleet, the Elysia and the Massilia, are to be converted to this system, which will shortly be applied to the company's Atlantic liner the Columbia. The chief claims made by the inventor of this system are the low initial cost and the small space occupied by the plant, and the flexibility and economical working of the burner. A rotary fan is used to provide the air necessary for atomisation and combustion, and a low pressure of from 6 oz. to 7 oz. per square inch, which practically corresponds with the pressure of the gravity-fed fuel oil is used. The burner is of simple construction and consists of three cylindrical radially concentric passages, with a series of non-rotatable blades fitted inside the atomising device. Air and fuel-regulating valves are provided, along with an external adjustment, which allows fuels of varying viscosities to be used. The system is also capable of application to cooking ranges, and will be so applied on the vessels we have named.

British Textile Machinery in China.

Speaking in the House of Commons on the 19th inst., Colonel Dobson explained a scheme put forward by the Textile Machinery Makers' Association of Lancashire for the establishment of a textile technical school at Shanghai, the cost of which, it was suggested, should be defrayed out of a portion of the remitted Boxer Indemnity. This scheme has already been referred to in the Journal of our issue of March 16th. From the early development of the cotton-spinning industry in China, practically all the machinery up to the beginning of the war has been supplied by Lancashire firms, but the present serious position was indicated by the number of spindles supplied by British and American firms since 1915. According to returns, the American shops had supplied 891,974 spindles, as against 947,936 spindles of British make over the same period.

Sixty Years Ago.

Turning to The Engineer for April 24th, 1863, we note that matters relating to shipbuilding and marine engineering were prominent in that issue. In an interesting article on the construction of twin screw steamships, Commander T. E. Symonds, R.N., discussed the disadvantages of the single screw and outlined a new method of fitting twin screws whereby the old heavy stern-post frame was lightened. At the time a Parliamentary Committee was sitting to inquire into the position of naval officers, and one of our leaders is devoted to the subject of naval engineers, and was a plea for a more generous consideration of their status and pay. Some figures were given concerning the pay of American naval engineer officers. A chief engineer in the American service was paid £525 per annum, a first assistant engineer £250, and a third assistant £150. These rates were stated to be considerably better than those of the British naval services at that time. Shipbuilding on the Thames was again to the fore. We read of the trials of the Peninsular and Oriental steamer Carnatic, built by Messrs. Samuda, and engined by Humphreys and Tennant, of Deptford. She had a length of 315ft., with 2800 tons displacement. The machinery consisted of a pair of combined cylinder engines inverted, two of the cylinders being 43in. in diameter and the other two 96in. diameter, with 36in. stroke. The boilers were Lamb's sheet flue boilers, and the vessel was propelled by a two-bladed screw with the corners cut off. This screw had a diameter of 16ft. and 23ft. pitch. At the trials the engines, which were designed for 400 horse-power nominal, indicated 2442 horse-power, or six times the nominal horse-power. It is stated that four times the nominal horse-power was generally considered good for a new vessel.

Institution of Mechanical Engineers.

HARDNESS TESTS.

At last Friday's meeting of the Institution of Mechanical Engineers in London, two papers were presented for discussion describing work done for the Institution's Hardness Tests Research Committee. Both the authors, Mr. G. A. Hankins and Mr. R. G. C. Batson, are members of the staff of the National Physical Laboratory. Mr. Hankin's paper was entitled "On the Relation between Width of Scratch and Load on Diamond in the Scratch Hardness Test," while Mr. Batson's bore the designation "Static Indentation Tests."

STATIC INDENTATION TESTS.

Mr. Batson's paper was divided into three quite separate parts. In the first he sought to extend Meyer's law of comparison for ball indentation tests. In the standard Brinell test the ball has a diameter of 10 mm., and the load applied to it is 3000 kilos. for hard materials and 500 kilos. for soft. Conditions, however, may arise under which it is not possible or convenient to use a ball of the standard diameter. If the diameter is changed, what change should be made in the applied load? In 1908 Meyer showed that the law to be followed when the diameter of the ball was changed was one of geometrical similarity of the deformation produced. From this law it follows that with a ball of diameter D results comparable with those obtained with the standard conditions will be obtained if the load P is chosen such that $P = 30\ D^2$ for hard metals or $P = 5\ D^2$ for soft. Meyer's law was verified experimentally by himself with balls of less than standard 10 mm. diameter. Mr. Batson has now investigated it for balls ranging from 5 mm. to 50.8 mm. in diameter, and has found that it holds good sufficiently well for use in accurate testing work. In the course of his experiments he received confirmation of H. Moore's rule that the width of the test piece should be at least $4\frac{1}{2}$ times the diameter of the impression produced. With the 50.8 mm. ball this condition was not completely fulfilled, and the results appear to have been affected as a consequence.

In the second portion of his paper Mr. Batson instituted a comparison between the ball and the Ludwik cone indentation tests. It is claimed for the cone test that as the indentations are geometrically similar, no matter what may be the depth of the impression, the hardness figures obtained by it are independent of the applied load, whereas in the ball test the indentations are geometrically dissimilar and the hardness number varies with the applied load. In both instances the hardness number is calculated as the ratio of the applied load to the area of the spherical or conical surface of the impression. The area of the surface may in each case be calculated either from the diameter of the impression or from its depth. In most metals—manganese steel is one exception—the impression of the indenting tool into the specimen causes the metal to rise up as a ridge round the lip of the indentation. It is customary, when the area of the indented surface is calculated from the diameter of the impression, to measure that diameter at the top of the ridge and not in the plane of the original surface of the metal. Where the area is calculated from the depth of the impression, it is usual, however, to measure that depth from the original surface of the metal; that is to say, to neglect the additional height represented by the ridge. Mr. Batson investigated the influence of these variables in the case of three steels and a brass, using a 10 mm. ball and a 90 deg. cone. For the ball tests he has confirmed the previously known facts that with the same size of ball on the same material different hardness figures will be obtained with different loads if the spherical surface is calculated from the diameter of the impression at the top of the ridge, but that the hardness figure will be substantially constant with different loads if the spherical surface is calculated from a measurement of the depth of the impression below the original surface. In the case of the cone test his results indicate that the exact opposite is true, so that the conical surface should be calculated from the diameter at the top of the ridge. He has farther shown that the ratio of the ball to the cone figures is not constant either for diameter or depth determinations, nor we notice, is it constant either for ball diameter, and cone depth, or for ball depth, and cone diameter. Still more variable ratios, it is stated, are obtained, if, as has been suggested, the hardness number is in either case defined as the ratio of the load to the projected, as distinct from the spherical or conical, area of the impression.

In the third part of his paper Mr. Batson gave some results obtained with a method of measuring the hardness of very hard steels by determining the permanent deformation suffered by the ball instead of by the specimen. The method involves the use of a very accurate spirit level, and is suitable only for refined laboratory investigations, but it yields a very open scale of readings at the higher hardness values, one instrument division corresponding to a flattening of the ball of 0.0000032in. By means of the method, it has been shown that the Brinell hardness figures, as ordinarily determined on hard materials, depend very much upon the material and hardness of the ball used, and may differ with different observers by from 50 to 100 points on the Brinell scale. We presume that this deduction is based on the assumption that in the ball-flattening test the hardness of the specimen is proportional to the simple linear reduction of the diameter of the ball in the direction of the applied stress.

SCRATCH HARDNESS TESTS.

The scratch hardness test, we may recall, has previously been applied in different ways. In Turner's original method the test specimen was subjected to the scratching action of a diamond point to which a varying series of loads was applied. The hardness of the specimen was defined as that load in grams, which would produce a scratch on it visible to the naked eye. Martens subsequently made the test more definite by defining the hardness as the load in grams which would cause a 90 deg. conical diamond to produce a scratch 0.01 mm. wide. The obvious method of defining hardness as, or as some function of, the ratio of the load on the diamond to the dimensions of the scratch produced, has hitherto presented difficulty by reason of the fact that as ordinarily carried out this ratio is not constant, as the load is varied on the one material. In Mr. Hankin's paper this fact is accounted for, the measure of hardness is suitably modified and the figures yielded by the modified measure are compared, and shown to be in regular mathematical relationship, with the corresponding Brinell hardness figures.

Mr. Hankin's instrument—Fig. 1—consists of a diamond-pointed plunger, freely sliding in a bridge-piece and variously weighted at its upper end, the plunger being restrained from rotating. The specimen against which the diamond rests, is mounted on a carriage which can be moved longitudinally by hand by means of a leading screw. In some instances the specimen was mounted inclined, as shown. In others it was packed up horizontally. The shapes of the three principal diamonds used are shown in Fig. 2. It was soon discovered that the apices of the four triangular faces of diamond No. 1 did not accurately meet at a point, and that even with diamond No. 2 the cross-section of the scratch produced was apparently a trench with sides sloping at 36 deg. to the vertical, and a flat horizontal bottom about 0.005 mm. wide. Diamond No. 3 represents an effort to produce a form to specified angles and with a sharp edge. It was found that the lower rake, instead of being 5 deg. as intended, came out at $13\frac{1}{2}$ deg. The machine was accordingly modified as shown in Fig. 3, the diamond holder being mounted at the end of a flat spring, and tilted to reduce the angle between the diamond edge and the specimen to $3\frac{1}{2}$ deg.

Preliminary tests with diamond No. 2 revealed the fact that satisfactory scratches with clean edges and of uniform width could not be obtained if the specimen were moved in the direction towards the vertical face of the diamond, but only if the direction of movement were reversed, as indicated in Fig. 4. Experience showed that the most satisfactory scratches were produced when the scratching was silent, and when it consisted, apparently, of a flow of the material of the specimen without the production of shavings or the removal of the substance.

In Fig. 5, the results obtained from five steels, showing the width of scratch plotted against the load on the diamond, are given. The curves, it will be noticed, are satisfactorily uniform. Plotting the

FIG. 1.—*General Arrangement of Instrument as used with Diamond No. 2.*

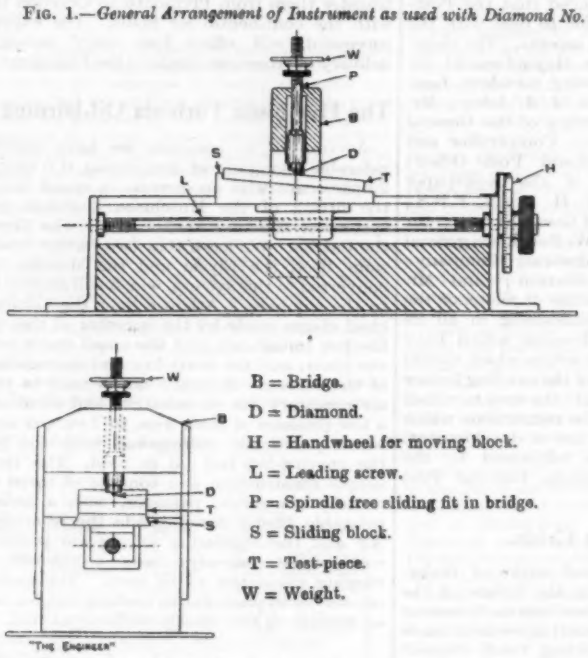


FIG. 2.—*Diamond No. 1.*

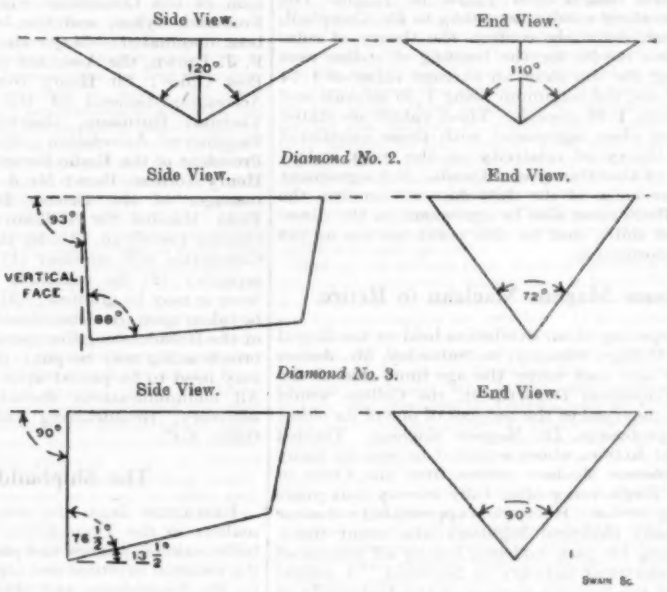


FIG. 3.—*Arrangement of Spring Holder as used with Diamond No. 3.*

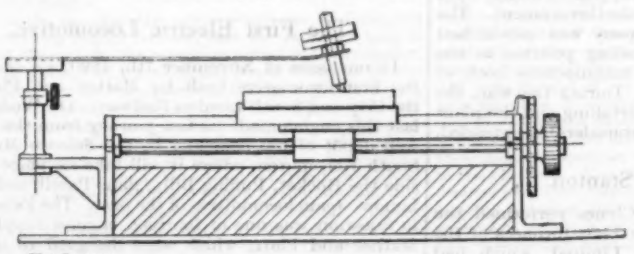


FIG. 4.—*Arrow shows Direction of Motion of Test-piece.*

squares of the widths against the loads approximate straight lines were obtained in each instance, and when these lines were transferred to one diagram —Fig. 6—they showed a tendency to intersect at a common point which was not the origin. These results were confirmed by means of diamond No. 3, the only difference being that the straight lines intersected at a different point.

tion of the spherical area. With reference to the relation between the size of the ball used for the test and the load applied to it, he thought it would be better to settle on, say, two sizes and loads, instead of allowing a choice between several, as suggested by Dr. Batson. He recommended the use of a 10 mm. ball with a load of 3000 kilos. and a 4 mm. ball with a load of 500 kilos. Dr. Unwin laid some stress on the

some tests carried out by Dr. Unwin on the penetration of armour plates by projectiles. Martell had proved that the volume of the indentation was nearly independent of its shape, and that the indenting pressure was proportional to the projected area of the indentation. Dr. Unwin thought that these two laws might form the basis of a system for testing hardness in which general agreement would be arrived

FIG. 5 —*Characteristic Curves of Width against Load.*

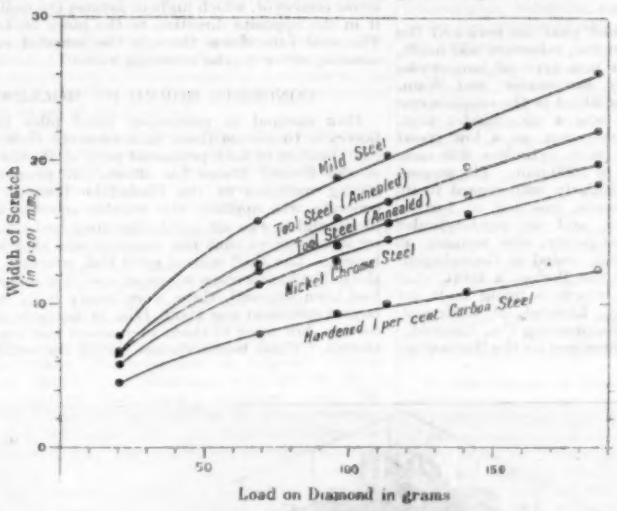

Width of Scratch (in 0·001 mm.)
Load on Diamond in grams
Mild Steel
Tool Steel (Annealed)
Tool Steel (Annealed)
Nickel Chrome Steel
Hardened 1 per cent Carbon Steel

FIG. 5a

Characteristic Curves of (Width)² against Load.

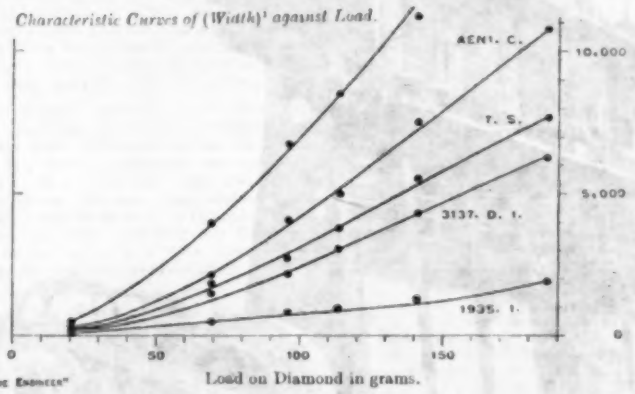
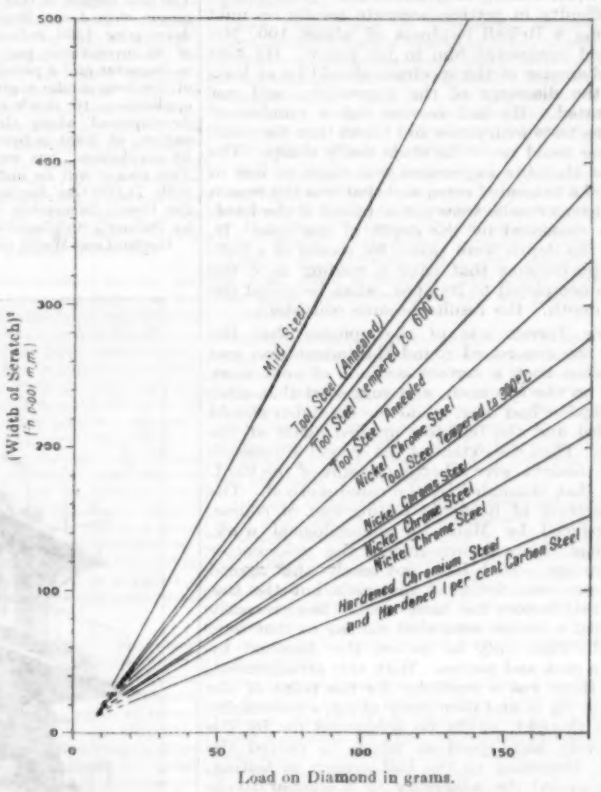


FIG. 6.—*Diamond No. 2.*



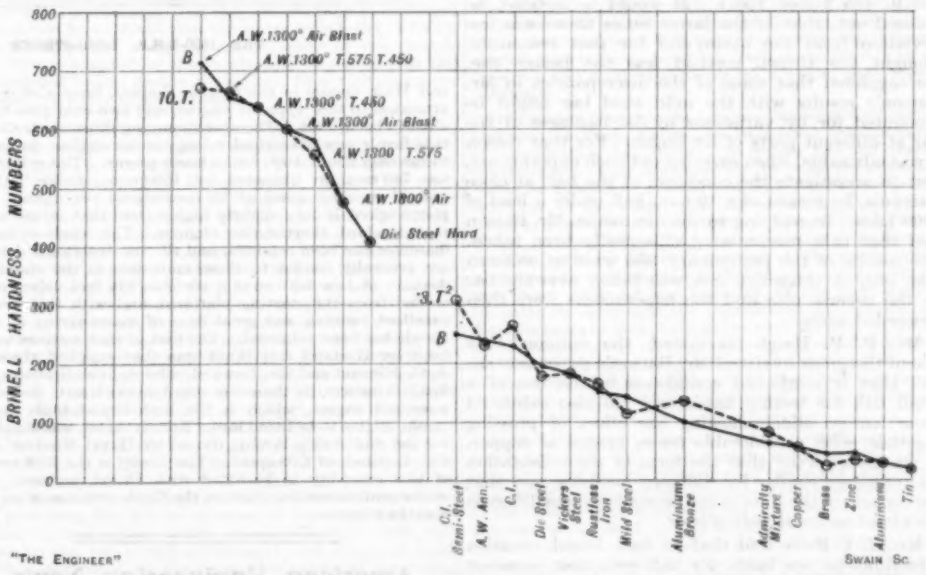
The deduction is made that a straight line law holds between the square of the width and the load on the diamond, and that with any one diamond under constant conditions the straight lines intersect at a common point for all materials. If p and q are the co-ordinates of this point, it thus appears that a law exists of the form $(P - p) = k(w^2 - q)$, where P is the load, w the width and k a constant for each material. The quantity k is in the nature of a stress and it is suggested that it may be taken as a measure of the scratch hardness. When the scratch hardness figures, as thus defined, are compared with the Brinell numbers for the same materials they are bound to show an apparently regular relationship. They are not proportional to the numbers, but the ratio of scratch hardness to Brinell number shows a regularly varying value extending from about 2.0 for very hard materials down to a minimum of about 1.17 for materials of Brinell hardness number 450, and then up again to over 2.3 for soft mild steel. For the present it appears that the method will find chief use for measuring the hardness of the harder materials, or the hardness of materials of which only small or valuable specimens are available.*

Dr. Unwin, who opened the discussion, first made some comments on the new Herbert hardness testing apparatus, which was described in THE ENGINEER of April 13th, and which was exhibited at the meeting by the inventor, Mr. E. G. Herbert. The instrument was, he considered, very delicate in its indications, while the results obtained were extraordinarily consistent, yet it was of such a character that it could be put into general service; that is to say, it need not be confined to the laboratory. In dealing with the subjects brought forward by the papers just read, Dr. Unwin spoke chiefly about indentation tests, and suggested that it would be much more convenient if the hardness could be expressed as the load on the ball divided by the projected area of the indentation, rather than by the more complicated Brinell method, which involved the calcula-

investigations carried out by Dr. Batson on the comparison of the relation of hardness to the depth of the impression, as measured from the undistorted surface, and its relation to the spherical area of the indentation. The results arrived at indicated, he thought, that for ball tests the depth of the impression should be measured, whereas if a cone were used in the place of the ball, the diameter should be

at. The present systems were, he said, all empirica and did not appear to lead to any agreement.

Mr. E. G. Herbert was the next speaker, but as his remarks were principally concerned with a description of his tester, we need not, in view of our recent article, dwell upon them here. He illustrated his account with a number of lantern slides, some of which showed very graphically how a little wave



COMPARISON BETWEEN BRINELL AND HERBERT TESTS—BRINELL FULL LINES, HERBERT DOTTED LINES

measured. As an alternative, he suggested that it might perhaps be better to measure the depth, in all cases, from the top of the ridge that was generally formed round the depression. Many years ago Martell had carried out some experiments which showed that the amount of work expended in making the indentation could be used as a measure of the hardness, and those results were subsequently confirmed by

of the material being tested was pushed along by the ball as it rolled forward. He also showed a curve, which we reproduce, in which he made an attempt to prove a relation between his own hardness numbers and those obtained by the Brinell method.

Dr. Stanton pointed out that it should be borne in mind that the instruments described in the papers were still in the experimental stage and had not

* The significance of the quantities p and q was not discussed in the paper, but is obvious. Thus for w = zero, $P = p - kq$; that is to say, the diamond may be loaded up to a definite value, a value involving k and therefore dependent upon the material under test, without a scratch being produced. Again, for $P = p$ we have $w = \sqrt{q}$; that is to say, when the load has the value p the width of scratch produced will be independent of the material under test and will depend solely on the shape and sharpness of the diamond.—ED. THE E.

yet been developed to such an extent that they could properly be used in the workshop. He thought that Mr. Herbert's apparatus was a very interesting development, but considered that the "time" test taken with it was in the nature of an abrading process, while the "scale" test was comparable with the Brinell hardness reading.

Mr. Harold Moore said that present methods of testing might be empirical, but they should not be condemned on that account, as they were of proved utility in many industries. There would, he considered, be serious practical difficulties in applying Dr. Unwin's proposed limitation of the size of ball to two diameters. Thus at Woolwich it had been found necessary to use a ball as small as 1 mm. in diameter when testing thin materials. With regard to the difficulty in getting accurate results on mild steel having a Brinell hardness of about 100, Mr. Batson had misquoted him in his paper. He held that the diameter of the specimen should be at least 5 times the diameter of the impression, and not 4.5 as stated. He had carried out a number of indentation tests with cones and found that the point of the cone could never be made really sharp. The result was that the impression was more or less in the form of a truncated cone, and that was the reason why consistent results were not obtained if the hardness were measured by the depth of the hole. If, however, the depth were taken by means of a ball-pointed spherometer that gave a reading as if the cone were completed to its apex, what he called the "virtual depth," the results became consistent.

Professor Turner was of the opinion that the height of the rim raised round the indentation was an indication that a certain amount of cold work was done on the specimen, and suggested that after the indentation had been made the specimen should be annealed and the ball test applied again at the same spot. Then the extent of the second impression would, he thought, give a better measure of the hardness than that obtainded by the usual method. The scratch method of hardness testing was, of course, first introduced by Mohs for mineralogical work, and he had, himself, introduced the sclerometer forty years ago. With it he got results that agreed within 5 per cent. for most materials, but the test was not satisfactory for hard steel. More recently he had tried a device somewhat similar to that used by Mr. Hankins, only he moved the diamond by means of a rack and pinion. With this arrangement, however, there was a tendency for the point of the diamond to dig in and then jump along, a peculiarity which, he thought, might be accounted for by the comparatively high speed at which he moved the diamond. Reverting to the ball system of testing, he recommended the adherence to a comparatively small number of weights, suggesting 10, 50 and 100 kilos. for the purpose.

Professor Philpots discussed at some length the relative merits of the expression used by Meyer, $\frac{P}{\frac{\pi d^2}{4}}$, and that used by Brinell, $\frac{P}{\text{spherical area}}$. He had calculated out the hardness, according to both these methods, from the results of the tests given by Mr. Batson in Table I. of his paper. The figures he obtained were, taking the tests in five groups and averaging, 93.34, 103.5, 111.8, 116.4 and 120.6 for the Meyer system. Using the Brinell expression the corresponding figures were 90.6, 100.2, 105.9, 105.9 and 106.1. It would be noticed, he pointed out, that in the latter series there was less deviation from the mean, and for that reason he thought the Brinell method was the better one. He suggested that some of the discrepancies in Mr. Batson's results with the mild steel bar might be accounted for by variations in the hardness of the bar at different parts of its length. For that reason it was advisable, when carrying out such experiments, first to investigate the condition of the bar, at close intervals, by means of a 10 mm. ball under a load of 3000 kilos. In replying to the discussion, Mr. Batson said that that precaution had actually been taken. The results of the preliminary test were so uniform that only a skimming cut was taken over the bar on the reverse side and the experiments were then proceeded with.

Mr. B. P. Haigh expressed the opinion that one of the great merits of Mr. Batson's paper was the fact that it reinforced confidence in the use of a small ball for testing hardness. He also exhibited some lantern slides showing the effect of pressing together, with considerable force, prisms of copper. It was noteworthy that the form of the indentation was precisely similar for different loadings, and that the contour of the sides of the depressions was different with hard and with soft copper.

Mr. R. T. Rolfe said that he had found occasion sometimes to use loads for ball tests that were not commonly applied. He had thus plotted curves connecting the hardness numbers with the loads, so that appropriate corrections could be scaled off the curves for application to the results got with the unusual loads. These curves were very similar from those obtained by Mr. Batson. He did not see any merit in departing from Brinell's method of computing the hardness, as none of the expressions put forward gave such good results. Professor Le Chatellier had suggested the equation

$$H = \frac{P_1}{A_1} \times \sqrt[8]{\frac{D^1}{10}} \times \frac{20{,}000}{17{,}000 + P_1}$$

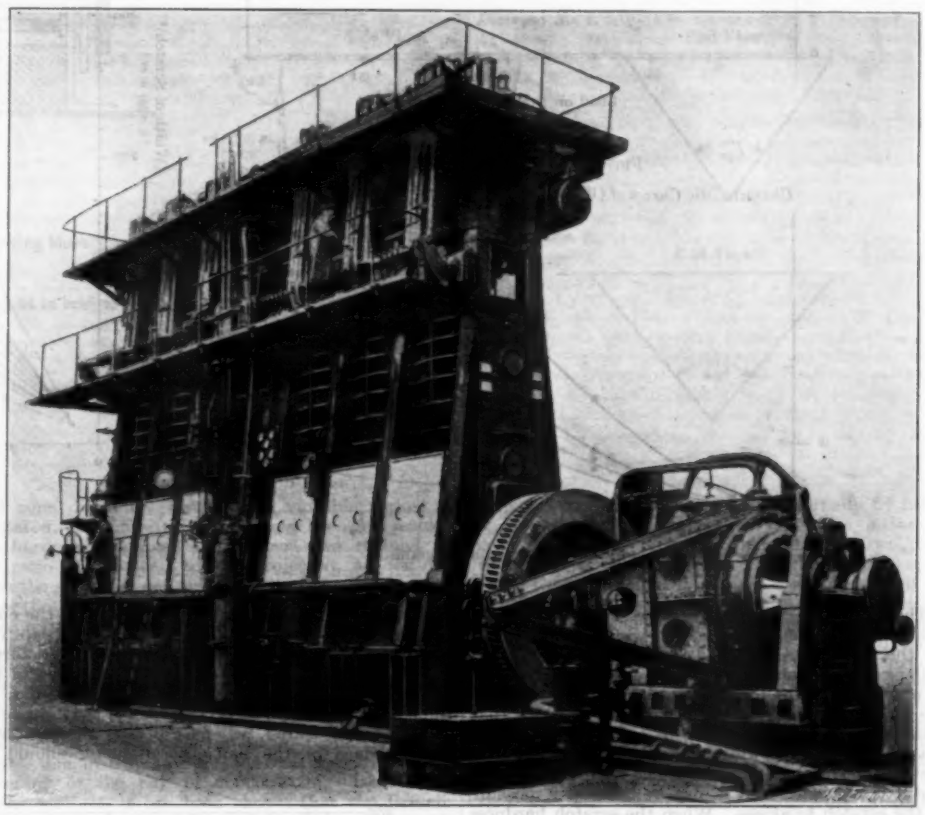
but even that was not so good as the comparatively simple Brinell system.

As the discussion had occupied an unusually long time, the authors promised to reply in writing.

The Long-stroke Diesel Engine.

When at the beginning of last year we reviewed the progress of the marine Diesel engine, reference was made, and an illustration given, of a new type of long-stroke engine, designed and built by Burmeister and Wain. The first engine of this type was fitted in the single-screw motor ship Leise Maersk. It was a six-cylinder unit, developing 1500 indicated horse-power, at a low speed of 85 revolutions per minute, with cylinders 630 mm. in diameter and a piston stroke of 1300 mm. The success of the long-stroke engine, particularly with regard to its application to single-screw vessels, has led to further development along these lines, and an eight-cylinder engine, of 3000 indicated horse-power, also running at 85 revolutions, has recently been tested at Copenhagen. This motor will be installed in the Medon, a 400ft. ship with 11,000-ton displacement, which is being built for the Ocean Steamship Company, Limited, of Liverpool, by Palmer's Shipbuilding and Engineering Co., Limited.

Harland and Wolff, the main licensees for the Burmeister and Wain engine in the British Empire, have also given attention to this type of engine, and two examples have already been built. The accompanying illustration shows this firm's new six-cylinder long-stroke engine, designed to develop about 1800 brake horse-power. The cylinders are 740 mm. in diameter by 1500 mm. stroke. At a normal running speed of 85 revolutions per minute the piston speed is only slightly higher than that in use with the standard short-stroke engines. The same cylinder diameter has been retained, and the constructional details are generally similar to those embodied in the standard design. A new feature is a variable lift fuel valve, controlled from the starting platform, and with this device excellent running and great ease of manœuvring at low speeds has been achieved. The first of such engines to be built by Harland and Wolff was that supplied through J. G. Kincaid and Co., Limited, who are sub-licensees, to Spanish owners, for the motor ship Arantza Mendi. Recently a second engine, which is the first British-built long-stroke engine to be fitted into a British vessel, was supplied for the motor ship Araby, owned by David MacIver and Co., Limited, of Liverpool. The Araby is the first vessel of this company to be fitted with Diesel engines. She underwent successful trials on the Clyde and is now on her maiden voyage.



THE 1800-B.H.P. LONG-STROKE ENGINE OF THE MOTOR SHIP ARABY

American Engineering News.

(From our own Correspondent.)

BURNING PULVERISED FUEL.

It has been found that many American boiler plants which use fuel are failing to obtain complete economy owing to neglect of details in operation. Ash loss is very slight, but many plants secure this result at the expense of excess air, owing mainly to feeders which require constant adjustment. Investigation shows that the efficiency of the coal varies continuously according to the varying amount of air mixed with it as it approaches the feeders. Although the feeder adjustment and the combustion air supply may be kept constant, yet the character of the flame and the combustion efficiency will fluctuate. This seems to be accounted for by the fact that as the coal stands or shifts in the bins it changes its air content, the air sifting out of the coal when at rest, but being picked up or entrained as the coal slips or slides. A burner which will give a constant coal condition at all times is essential if automatic control is to be applied, and constant watching and adjusting are to be eliminated. To meet this requirement, one recent form of burner has a screw conveyor, which fluffs or aerates the coal by pushing it in the opposite direction to the main feeder conveyer. The coal runs down through the serrated edges of the aerating screw to the metering valve.

CONCRETE BORED BY MOLLUSCS.

One method of protecting wood piles from marine borers is to encase them in a concrete shell, but recent examination of such protected piles at Pacific coast ports of the United States has shown the presence of rock-boring molluscs of the Pholadidæ family. When the concrete was applied, the wooden moulds were left in place, and it was not until after they had been destroyed by wood borers that the concrete was attacked by rock borers. The shell was of good rich concrete about 2½in. thick, but in one place where an area of about 5 square feet had been exposed, there were nearly forty borers. The largest specimen was about 1¾in. in diameter at its largest section, but most of them were about the size of a man's thumb. These borers do not attack the wood, but when they reach it they bore along parallel with it, keeping within the concrete. Although the possibility of attack of concrete in marine works by the borers which penetrate even hard rock was known, the present cases are believed to be the first specific instances on record. The extent of the attacks also indicates that they may constitute a serious difficulty in certain locations. Thus the rock borers not only destroy pile protection but in mass concrete they might cause water to reach the steel reinforcement, resulting in rust and spalling off of the concrete.

NEW YORK TROLLEY OMNIBUSES.

The "trackless tramcar" operating on the public roads and taking current from an overhead wire is being used to a considerable extent in the United States. Two lines aggregating 15 miles are operated by the City of New York on Staten Island, where routes amounting to 200 miles have been planned by the city's engineers. The country is hilly, and being close to the mainland, the island has residence districts and summer resorts as well as manufacturing and rural sections. The new omnibuses are designed along the line of the automobile rather than the ordinary omnibus, the entrance and exit doors being in the side of a vestibule at the front end of the body and just behind the rear wheels. Two 25 horse-power motors in tandem are geared to disc wheels having solid 36in. tires 6in. wide, the rear wheels having two tires each. The body is 26ft. 6in. long, 6ft. 10in. wide, and 6ft. 4in. high, with its vestibule floor 28in. above the pavement. It carries thirty passengers on a combination of transverse and side seats. The frame and side panels are of steel, with wood lining and roof. The storage shed and repair shop for these lines has concrete pits over which the omnibuses are placed for convenience in inspecting and repairing the motors and machinery. Current at 600 volts is supplied, and the omnibus has a trolley pole with two contact wheels riding on two trolley wires spaced 14in. apart and carried by span wires between wood poles 30ft. high.

Railway Matters.

THE London, Midland and Scottish Company has given notice of temporary alteration of trains on the Manchester, Victoria–Oldham line from May 1st "to apply during the electrification of this section."

AS anticipated in this column last week, the railway companies are bringing a further reduction in rates into operation on May 1st, which will bring the general level to 50 per cent. above pre-war rates. The cost to the companies is placed at £9,000,000.

ON Monday last, the 23rd inst. and the following day, the Delaware and Hudson Railway Company celebrated the hundredth anniversary of the granting of a charter to the Delaware and Hudson Canal Company, which subsequently became the owner of the railroad.

THE Great Western Company is appealing to its engineers to save coal by taking less fire to the shed when their engine's work is done. One shovelful of unburnt coal for each engine trip on the Great Western would result in an annual economy of 10,000 tons.

IT is officially announced, in respect of the question of shopmen's wages mentioned in this column on April 13th, that "some modifications have been made by the companies of the previous proposals put forward, and the representatives of the craft unions are taking these to their various executives for consideration."

THE stores department appointments for the London and North-Eastern Railway are as follows:—North-Eastern area: Mr. R. C. Richardson, with Mr. W. H. D. Devey as assistant, Gateshead; Southern area: Mr. H. A. Butler, Doncaster, and Mr. W. H. Pryce, Gorton; Southern Scottish area: Mr. A. McIsaac, Cowlairs; Northern Scottish area: Mr. C. P. Benzie, the factor for the area.

AMONG the honorary degrees to be conferred by the Manchester University on Founder's Day—the commemoration of the founding of Owens College in 1846—will be that of D.Sc. on Mr. W. B. Worthington, the immediate Past-president of the Institution of Civil Engineers, late chief engineer of the Midland Railway, and formerly chief engineer of the Lancashire and Yorkshire; and of LL.D. on Mr. Arthur Watson, M. Inst. C.E., the general manager of the London, Midland and Scottish Railway. Both were students of Owens College.

THERE are two separate passenger and goods stations in Oswestry, the Cambrian and the Great Western. Only a fence divides the two; the entrances are practically in the same street, and there is a physical junction between the two railways. Now that the Cambrian has been absorbed by the Great Western, both stations can be combined, and this is now to be done by the enlargement of the Cambrian station. The work will cost £61,000, and will include an engine turntable of 65ft. diameter. The Great Western station will then be closed.

THE Swedish Riksdag has appropriated 1,700,000 kr. towards the completion of the so-called Inland Railway by the construction of the section between Vilhelmina and Porjus. The same amount has been appropriated for the construction of the railway between Haellnaes and Stensele, also in Upper Norrland. The proposal to grant 700,000 kr. for the building of the line between Joern and Gubblijaure has been rejected, as it is desired to await the result of an inquiry into the plan for a change of direction of this line, with the view of exploiting the recently discovered rich deposits of copper and sulphur ore in these parts.

IN our leading article on "Railway Labour" in THE ENGINEER of November 3rd last, we expressed some anxiety as to whether the formation of the grouped companies under one administration might not lead to touch being lost between the companies and the men. We are, therefore, glad to hear that the London, Midland and Scottish Company has appointed Mr. G. S. Rider, of the late London and North-Western Railway, to be its general welfare superintendent. Mr. Rider's duties will cover the appointment training, general education and promotion of the staff, their health, accident prevention, and working conditions, and, it is important to note, the co-ordination and encouragement of the recreational side.

THE paper on "Railway Accidents," read by Mr. George Holt at the Institution of Railway Signal Engineers on the 11th inst., covered the twenty years 1901–1920, and showed the number of passengers, servants and "other persons" killed and injured on the railway during each of those years, together with the number of collisions and derailments reported and of the number of accidents inquired into. The last were divided by the author into one or other of 27 headings as to cause. There were 116 cases of drivers passing signals at "danger," and these were subdivided into 13 sub-headings; whilst where signalmen were at fault there were 182 cases, subdivided into 9 heads. Outside these the most prolific of the other 11 causes was "defects in permanent way or interference with permanent way by servants," of which there were 34 cases.

THE report on retrenchments in India, presented by the committee presided over by Lord Inchcape has, we hear from the Indian mail just to hand, given the railway officials there plenty to do. A point made is that renewals have been carried out to a hard and fast programme, with the result that work has been done earlier than necessary. One consequent recommendation is that on unremunerative lines renewals of permanent way should be limited to cases where the track is worn out and not capable of being strengthened to meet probable traffic requirements for a substantial period. The renewal of locomotives on these railways must be postponed. Concentration of the administration in Delhi or Simla is condemned and decentralisation recommended. The chief officer on each railway, corresponding to the general manager of the British railways, is termed the agent. It is recommended that these officers be designated general manager and made responsible for the administration, working and financial results of their railways. They are to be paid salaries more proportionate than they are now to the positions they hold.

Notes and Memoranda.

AN intensely white enamel, which exhaustive tests show is resistant to acids in a degree hitherto unknown, has, states *Industrial and Engineering Chemistry*, been developed by the Paint Department of the du Pont Company. The new enamel has been the subject of study for more than a year on the part of experts, and its development is expected to meet the need for protection of surfaces subjected to gas or fumes such as are found in hospitals, chemical laboratories, bakeries, rubber factories, canning plants, or for the interior of any factory or building where fumes are present.

THE analogy between the rubber and paint industries was pointed out recently by Dr. D. F. Twiss in the course of a paper read before the Institution of Rubber Industry at the Engineers' Club. The parallelism was so striking, he said, as to deserve brief review:—In both industries: (1) Powders (pigments) are dispersed as uniformly as possible in a viscous, chemically unsaturated medium; (2) the medium is submitted to subsequent chemical change—viz., oxidation in the case of the oil, and sulphuration in the case of rubber; (3) accelerators are introduced to expedite this chemical change. Litharge is an effective accelerator for both cases; (4) the fineness of the powders has an important bearing on the result; (5) the powders are not merely fillers or cheapeners, but improve the mechanical condition and ageing of the oxidised oil or sulphurated (vulcanised) rubber; (6) premature drying and premature vulcanisation are parallel difficulties.

IN the course of laboratory experiments on the desulphurisation of coke by steam, being conducted at the Pittsburgh Experiment Station of the American Bureau of Mines, steam tests at atmospheric pressure for the removal of sulphur from chunk size coke have been finished, with encouraging results. Combined sulphur as FeS, $FeSO_4$, and free sulphur (not including solid solution sulphur) in Ohio coke was reduced from 1.38 to 0.72 per cent. The solid solution sulphur was not affected, but it has been shown that this has very little effect in contaminating sponge iron in the blast-furnace. In Illinois coke, the sulphur content—0.62 per cent.—was reduced to 0.48 per cent. Clairton coke, low in sulphur, was reduced from 0.29 to 0.17 per cent. Sulphur in a sample of gas-house coke from Philadelphia was reduced from 0.81 to 0.60 per cent. These results were obtained without the application of a vacuum, which may reduce still further the amount of sulphur. Very little steam is required—3 grammes of steam per gramme of coke per hour were employed.

MECHANICAL stoking in conjunction with mechanical draught for marine service is having serious consideration, according to a paper read before the Institute of Marine Engineers by Mr. R. Clark, and a large number of Babcock marine boilers is being fitted with several types of forced draught stokers. However, there are certain disadvantages which must be referred to. Particularly where ships are already in service it is somewhat difficult to install the stokers, but where new ships are being built arrangements can easily be made whereby the designs can be so altered as to include the handling of the coal and ashes on an economical basis. Other disadvantages are the extra weight and complication involved, and also the difficulty of finding mechanical stokers suitable for the various classes of fuels which have to be dealt with on board ship. This difficulty, however, is gradually being overcome, and the results are very promising indeed. It is also difficult to show that mechanical stoking is an improvement over good hand firing, but the fact remains that it is difficult to find a really good fireman who will fire a boiler as efficiently and skilfully as a mechanical stoker. With a mechanical stoker a steady pressure is generally secured. It is not necessary to clean out fires because the stokers are self-cleaning and, taking a general view, Mr. Clark is of the opinion that sooner or later a big percentage of the ships now sailing will have mechanical stokers fitted where it is absolutely necessary that they should keep to coal fuel. There can be no doubt that the water-tube boiler, with its large combustion chamber, can be made to suit, and is far better adapted to the mechanical stockers than the cylindrical boiler, and it is on these lines that improvements are likely to materialise.

BEETLES which bore through lead cables, but which, nevertheless, do not or cannot penetrate pure gum rubber, have proved a serious problem and pest in California and many other parts of the United States. One of the most important injuries inflicted by these beetles is the damage done to the lead sheathing of telephone cables in California. The beetles bore circular holes in the sheathing, about $^1/_{16}$in. in diameter. Moisture enters the cable through these holes, causing a short-circuiting of the wires and interruption of service to the public. As one hole may put from fifty to six hundred or more telephones out of use for from one to ten days, the damage is rather extensive. Experiments have been undertaken at various times by the Bureau of Entomology of the United States Department of Agriculture to determine what treatment could be used to keep the beetles from injuring the cables. These experiments are summarised in a paper, issued as Department Bulletin 1107, "The Lead-cable Borer in California," by Messrs. R. G. Hartman, H. E. Burke and T. E. Snyder, entomologists. The results indicate that the beetle is able to penetrate any lead alloy used as a cable sheathing or any poison or repellant placed on it. Probably it is able to penetrate the poisons because it does not feed as it bores through. Beef tallow, when sufficiently soft, will stick to the beetle and suffocate it, and has been used with some success on the rings which suspend the cable, since practically all the boring is done near the rings. Layers of friction tape impede the boring and thin sheets of copper, zinc and steel prevent it. Sleeves of these metals can be placed around the cable at the rings, but the cost would probably be too great for general use. A new type of ring made of flattened steel wire stock and galvanised is now being installed by the telphone companies, and it is believed that this ring is better from the standpoint of preventing attack by the beetle than the old one. Meanwhile, tallowing the rings is the most promising method of control.

Miscellanea.

TORONTO harbour had in 1922 the greatest activity on record, according to the annual report just issued by the harbour master. There was an increse of 354 vessels arriving and departing in comparison with 1921, and an increase of 637,374 in tonnage. The gain in imports was 87,568 tons, and in merchandise exports 3843 tons.

THE need for a duty on scrap copper, scrap zinc, and scrap brass, all of which now enter Canada free, is urged by the Associated Boards of Trade of British Columbia. The position taken is that scrap metal is competing with the virgin metal produced in Canada, and that it should be treated by the tariff on the same basis as virgin foreign metals. A duty on base metals entering Canada is also recommended.

THE Department of Terrestrial Magnetism of the Carnegie Institution of Washington has turned its energies to the study of earth-currents, and is devising new methods of registration. Dr. S. J. Barnett, chief of the section of experimental work in pure magnetism, is vigorously prosecuting his researches on magnetism by rotation, and the converse effect. The investigation of atmospheric electricity is also being extended.

THE contract for the electrical equipment of the Quebec Development Company's power project at Lake St. John, has been secured by the Canadian Westinghouse Company, of Hamilton, Ontario. The equipment will consist of eight 40,000 horse-power hydraulic turbo-generators, 13,200 volts, 112 revolutions per minute, three-phase, 60-cycle, direct connected. The entire equipment is to cost about 1,090,000 dollars, and will take three years to complete.

AN improvement has taken place in the sale of coal and coke, and in the output of pig iron, steel and rolled products in Czecho-Slovakia. At the end of December three blast-furnaces were in operation, four more have been blown in since; but even now 15 are idle. On the other hand, unemployment in the engineering trade has hitherto shown no diminution. At the beginning of this year employment in the branch was 36 per cent. less than at the beginning of last year.

GERMAN competition in heavy electrical machinery sold in Japan has entirely disappeared, according to the American Commercial Attaché at Tokyo. Public statements made some time ago to the effect that Japanese buyers were inclined to place orders for this class of machinery with German manufacturers appear to have been only partly true, and it is now stated that no reliable Japanese company is either quoting for or endeavouring to secure the business for this sort of equipment of German manufacture.

FOLLOWING upon the consideration of tenders submitted to Bulgaria by an English firm, three French and one German, a contract has been awarded to the Bristol Aeroplane Company for three two-seater biplanes and three eight-seater limousines. The French Société pour Communications Aeriennes has been awarded a contract for seven two-seater monoplanes (L.F.G.V. 32 Bromberg). The Bristols will be mounted with 180 horse-power engines capable of 160 kiloms. an hour, with a "useful" weight of 590 kilos. The Brombergs will be mounted with 160 horse-power Mercédès engines, capable of 175 kiloms. an hour. The Inter-Allied Military Control Commission has sanctioned the supply of the machines, which are merely for transport purposes.

REPLYING recently to a question in the Punjab Legislative Council regarding hydro-electric schemes in the Punjab, the Hon. Lala Harkishen Lal said that certain tentative offers had been made to the Government by English financiers in connection with concessions for the hydro-electric schemes now under investigation in the Province. The Government was, he said, giving most serious consideration to the best way of financing hydro-electric schemes, and investigations were in progress. It was not yet possible to say what method would finally commend itself to the Government, but, generally speaking, it was considered that provincial ownership of hydro-electric undertakings would prove more profitable to the Province and more expeditious, as a whole, than private enterprise.

OF thirteen plans for the proposed underground moving pathway for Paris, which were submitted, the committee of examination has decided to retain five for further experiments. Four are based on the principle of parallel bands at graduated speeds, enabling passengers to step from one to the other until the most rapid is reached. Landing places would be arranged alongside the slowest of the bands. The fifth plan is based on the idea of variable speed; a platform moving slowly would enable passengers to embark; it would then gain speed, and only slow down again at the approach of the next station. In order to determine the possibilities, advantages and disadvantages of these various systems, the sub-committee has decided to carry out two trials over a circular distance of 300 m. The first trial will put to the test the merits of the four schemes which are similar, and the second trial will be made with the plan based on the principle of variable speed.

IRON and steel masters in common with employers connected with the rolling stock industry, are awaiting with some anxiety the result of the ballot vote on the new wages proposals now being taken amongst the workers in the railway wagon building and repairing trades. The outcome is obscured by the recent ballot on the memorandum arrived at in Derby with the Employers' Associations, which resulted in a majority of 2965 against acceptance. The proposals now being put before the workers reduces the previously proposed reduction of 10 per cent. to a reduction of 5 per cent. for certain piece-workers, and having regard to this fact, and because the terms generally are better than those obtained in engineering, shipbuilding and other industries, the men's leaders recommend them to vote in favour of acceptance. Industrialists in the Midlands hope that the week-end will show that the men have seen the justice and reasonableness of the employers' new memorandum and have given their approval thereto.

THE LAKESIDE ELECTRIC POWER STATION AT MILWAUKEE

(For description see page 437)

FIG. 17—VIEW ALONG OPERATING ROOM

FIG. 18—INTERIOR OF GENERATOR BUILDING

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—Mitchell's Book Store, 576, Cangallo.
CHINA.—Kelly and Walsh, Limited, Shanghai and Hong Kong.
EGYPT.—Cairo Express Agency, near Shepheard's Hotel, Cairo.
FRANCE.—Boyveau and Chevillet, Rue de la Banque, Paris. Chapelot and Cie., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. Combridge and Co., Bombay; Thacker and Co., Limited, Bombay; Thacker, Spink and Co., Calcutta.
ITALY.—Maglioni and Strini, 307, Corso, Rome; Fratelli Treves, Corso Umberto I, 174, Rome; Fratelli Bocca, Rome; Ulrico Hoepli, Milan.
JAPAN.—Maruzen Co., Tokyo and Yokohama.
AFRICA.—Wm. Dawson and Sons, Limited, 7, Sea-street (Box 49), Capetown.
C. Juta and Co., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—Gordon and Gotch, Limited, Melbourne, Sydney, Brisbane and Perth, &c.
Melville and Mullen, Melbourne.
Atkinson and Co., Gresham-street, Adelaide.
CANADA.—Dawson, Wm., and Sons, Limited, 67, Queen-street East, Toronto.
Gordon and Gotch, Limited, 132, Bay-street, Toronto.
Montreal News Co., 386–388, St. James-street, Montreal.
Toronto News Co., 42, Yonge-street, Toronto.
CEYLON.—Wijayartna and Co., Colombo.
JAMAICA.—Educational Supply Co., Kingston.
NEW ZEALAND.—Gordon and Gotch, Limited, Wellington and Christchurch; Upton and Co., Auckland; J. Wilson Craig and Co., Napier.
STRAITS SETTLEMENTS.—Kelly and Walsh, Limited, Singapore.
UNITED STATES OF AMERICA.—International News Co., 83 and 85, Duane-street, New York; Subscription News Co., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—British and Colonial Press, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—Agence Vox, 7, Rue de Surene, Paris (VIIIe).
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer,

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive The Engineer weekly and post free. Subscriptions sent by Post Office Order must be made payable to The Engineer and accompanied by letter of advice to the Publisher.

Thin Paper Copies.		Thick Paper Copies.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 18s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 16s. 6d. per annum
Thick paper edition .. .. £3 3s. 0d. ,,

*** Reading Cases, *to hold two copies of* The Engineer, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "The Engineer Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Drawing illustrating Details of a London and North-Eastern Railway "Pacific" Type Locomotive. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

The Engineer, April 27th, 1923. PAGE

The Lakeside Electric Power Station at Milwaukee.—No. III. (Illus.) 437
The Control of Boilers by Temperature and Draught Measurements. (Illus.) 437
Electric Transmission of Power for Propelling Machinery. (Illus.) 441
Packing and Despatching 442
A Seven-day Journal 443
Institution of Mechanical Engineers. (Illus.) 444
The Long-stroke Diesel Engine. (Illus.) 446
American Engineering News 446
Railway Matters 447
Notes and Memoranda 447
Miscellanea 447
Leading Articles—
The Hardness and Solid Viscosity of Metals 449
Corrosion 450
The Indian Railway Administration Report 450
Letters to the Editor—
Mechanical Couplers for Indian Broad-gauge Railways 451
Informal Meetings 451
Proposed Standard Keys and Keyways 451
Books Received 451
L. and N.E.R. Three-cylinder Locomotive—Details. (Ill.) 452
A New 30-Cwt. Lorry. (Illus.) 452
Extinguishing a Burning Oil Well 453
30-Ton Floating Crane for Karachi. (Illus.) 454
An Exhaust Gas Water-tube Boiler. (Illus.) 455
Clearing Bessemer Converter Spouts 455
A Vision of Terror 455
Large Hydro-electric Power-house in California. (Illus.) 456
Australian Engineering Notes 456
Provincial Letters—
The Midlands and Staffordshire 457
Lancashire 457
Sheffield 458
North of England 458
Scotland 459
Wales and Adjoining Counties 459
Contracts 459
Current Prices for Metals and Fuels 460
French Engineering Notes 461
British Patent Specifications. (Illus.) 461
Forthcoming Engagements 462
Personal and Business Announcements 462

Two-page Supplement—L. and N.E. Railway "Pacific" Type Locomotive—Details.

THE ENGINEER.

APRIL 27, 1923.

The Hardness and Solid Viscosity of Metals.

The papers read and the discussion thereon at the Institution of Mechanical Engineers last Friday night do not, it seems to us, carry our understanding of the perplexing phenomenon of hardness in metals much farther than it was before. Indeed, in some respects they serve rather to complicate the issue than to clarify it. Mr. Hankins has succeeded, it is to be noted, in establishing the scratch hardness test on a much more definite and scientific basis than that on which it previously rested. He has shown that it can be carried out in such a way that it yields rational hardness figures which bear a definite relationship, though not a simple one, to the Brinell numbers for the same materials. Mr. Batson likewise has done good work in extending and confirming Meyer's law of geometrical similarity for balls up to 50.8 mm. in diameter. He has also confirmed our previous knowledge regarding the influence on the hardness numbers arrived at, of the ridge thrown up in most materials by the ball used in the Brinell test, and has definitely shown that figures independent of the load used will be obtained only if the ridging is neglected and the spherical area of the indented surface is calculated from a measurement of the depth of the impression below the original surface. He has added the new fact to our knowledge that in the Ludwik cone test the exact opposite requirement holds good, that in this case we must take account of the ridging and calculate the conical surface of the indentation from a measurement of the diameter of the impression across the top of the ridge. In the final part of his paper he described the application in practice of a method previously suggested of measuring the hardness of very hard steels, namely, by measuring, not the indentation produced by the ball in the steel, but the permanent deformation caused by the steel on the ball.

These various investigations and results, as we have said, do not extend our knowledge of hardness to any important extent. Indeed, we have to confess that in some respects we are troubled by them from the purely scientific point of view, while from the practical they are distinctly upsetting. Mr. Hankins has found that satisfactory, consistent results cannot be obtained from the scratch test unless precautions are taken to prevent the diamond from scratching the metal—that is to say, to prevent it from removing any portion of the material as a shaving or otherwise. The scratch must be caused by a flow of the material round the diamond point without severance of the substance of any kind. This extraordinary paradox places us scientifically in the position of having to abandon the widely accepted view that the scratch test figure is a complex measure of various fundamental properties of a material with the resistance to shearing as the predominant factor. Instead, we must apparently regard the scratch test as measuring primarily the "flowability" of the metal. Perhaps, however, it would be better to adopt the view that the Hankins scratch test is not at all a measure of the scratch hardness as ordinarily understood—say, as understood by Turner or Martens—and to think of it as fundamentally related to the Brinell or other tests in which the indentations are produced by, in part at least, a flow of the metal. Is not this view confirmed by the fact that for the first time a smooth mathematical connection has been established between "scratch" figures and Brinell numbers? From the practical point of view, Mr. Hankins' results and observations are, apart from the reaction of the scientific aspect, upsetting, because they show that comparable results can only be obtained by the use of the one diamond on the whole series of metals which it is desired to compare for hardness, and that it is exceedingly difficult to find and practically impossible to produce two diamonds sufficiently similar to be used interchangeably. Mr. Batson's extension of Meyer's law to large-sized balls is a result purely of practical significance. Anything scientific which we might deduce from it was deducible before from the knowledge that the law held good for ball diameters below 10 mm. His second set of conclusions, regarding the ridging, present an apparent paradox which scientifically calls for investigation, while practically they point definitely to the conclusion that to obtain results from the Brinell ball test which are not to contain the possibility of material error, we must abandon the generally followed and fairly simple process of measuring the diameter of the impression in favour of the more difficult process of measuring its depth. Alternatively, of course, we may adhere to diametral measurements, but if we do we must give up the Brinell ball test and adopt the Ludwik cone test. In the third part of his paper Mr. Batson dealt with a method of test which at present at least is of purely scientific or laboratory interest, for it would clearly be impossible to use the very delicate spirit level and its attachments under workshop or tool-room conditions. Indirectly, the results established by Mr. Batson in this section may be held to have an adverse feature from the practical standpoint, for they apparently show that the hardness numbers derived by the Brinell method from steels in the higher range of the hardness scale are open to serious error, an error amounting in some cases to as much as 100 points on the scale—that is to say, they may show a percentage error of between, say, 14 and 16. We do not, however, feel inclined to attach undue importance to this revelation, for, in the first place, it has always been recognised that the high figures contained a considerable margin of error, and, secondly, because we are not yet wholly satisfied that the particular method of evaluating the error here adopted yields figures which permit a strict comparison to be made. It seems to require establishment that the figures obtained by measuring the indentation produced in a relatively soft metal by a relatively hard ball do measure the same property or properties of the metal as those figures obtained by measuring the permanent deformation of a relatively soft ball when impressed against a relatively hard metal.

On the whole, we think it will be agreed that the papers are of chief interest from the scientific aspect, particularly Mr. Hankins'. Holding, as we have been inclined to do, that hardness in metals—or, at any rate, that quantity which is accepted as such in the Brinell and other indentation tests—bears a close relationship to, if it is not actually identical with, the property of the metal which, if it were a liquid or a gas, we would call its viscosity, we are naturally greatly interested in the establishment of the fact that conditions of flow rather than scratching were found to be essential to the success of Mr. Hankins' form of "scratch" test. We have before pointed out that the "dimensions" of the Brinell hardness number are identical with those of fluid viscosity, except for the omission in the denominator of a time factor, an omission which we believe will be made good when the undoubted time effect in hardness testing has been more fully studied. If a sufficiently detached view of Mr. Hankins' experimental procedure be taken, it will be recognised that were we setting out to investigate the existence and amount of the suggested property of solid viscosity, we would probably adopt the self-same details and method as used by Mr. Hankins for the measurement of "scratch" hardness, although we would arrange to pay more attention to the time rate of

"scratching" than he appears to have done. It is of interest to note in passing that, in the course of the discussion, Professor Turner attributed his own failure with scratch tests to the fact that he moved the diamond too fast. The regularity of the relationship which Mr. Hankins shows to exist between his "scratch" test figures and the Brinell numbers for the same series of specimens strongly suggests, although, of course, it does not prove, that the two tests measure the same property or group of properties of the metals, the absence of strict proportionality being accounted for by the different way in which the property is measured or the different way in which the individual members of the group of properties is compounded to make the complex. If we may argue thus, we may come to the conclusion which we have previously arrived at by other lines of argument, that the Brinell and other indentation tests for hardness, as well as the new variant of those tests, the Hankins' "scratch" test, may reasonably be held to measure wholly or in large part what we may call the property of solid viscosity in metals.

Corrosion.

The more one studies the problems of corrosion, whether of ferrous or non-ferrous metals, the deeper does his mystification become and the greater grows the certainty that no theory yet advanced is even approximately satisfactory. For a long time the mechanism, as it is called, of corrosion was held to be electrolytical, then the chemists came in with the CO_2 theory, only to make way once more for the electrical people, who returned with a thoroughly up-to-date theory, fully equipped with ions and all the paraphernalia of electrochemical action. Now they, in their turn, have been assailed by a new hypothesis, which, calling upon the resources of the latest chemistry, associates corrosion with colloidal activities. And so it goes on. We have no doubt that when another new phase of electrolytical, or chemical, or physical science is propounded someone will seize upon it to explain the processes of corrosion, and, in due course, his theory having met with the fate of all its predecessors, a new one, based on still later concepts, will be advanced. Fortunate it is in these circumstances that, as Dr. Hatfield said at the conference in Sheffield a fortnight ago, "from the industrial standpoint, it is not quite so important that an adequate theory should be devised as that progress should be made in the development of metals and alloys suitable for meeting the demands of the mechanical arts." There is, Dr. Hatfield said later, no obvious law or set of laws at present available, nor any working theory sufficiently satisfactory to render effective aid to the worker on corrosion.

The conference in Sheffield to which we have referred—a conference in which the Faraday Society, the Institute of Metals and the Manchester Metallurgical Society took part—did nothing whatever to clear up the confusion of theories to which we have alluded. Yet it served a useful purpose, for, at any rate, it provided us with an outline, rather vague and uncertain perhaps, of the position of the science of corrosion at the present day. But in doing so it only served to show more clearly than ever how little science has been able, with the greatest of endeavours, to prevent the wastage of metals. The researches of Bengough, of Friend, of Desch, of Hatfield, and many other careful workers fill us with admiration, and compel our respect, but we are forced, reluctantly, to admit that the real advances have been made by empirical methods or by the observance of workshop and industrial events. The most justly celebrated of all non-corrosive ferrous alloys was discovered by chance, and one of the most remarkable of non-corrosive non-ferrous alloys—Monel metal—is a natural product in which the wisdom of man has no part. The most useful of all scientific deductions as to the nature of rusting, namely, that perfectly pure iron was immune, led to the production of ingot iron, but as an industrial metal that product has never made such progress as would lead one to look to it as the structural material of the future, and that must be regarded as the touchstone of non-corrodible ferrous materials. Again, perhaps the most successful plan for preventing the corrosion of tanks and boilers was founded on a full belief in the sometimes discredited electrolytical theory. When we turn to brasses and bronzes the position is still worse, for we have not even the satisfaction of knowing that a non-corrodible alloy has been discovered accidentally, and the continued failure of condenser tubes, despite the costly and admirable work conducted by the Institute of Metals, leaves us with little cause to believe that years of elaborate research have placed us in a better position than before. One of the earliest convictions as to the cause of the wasting of brasses and bronzes was that the admixture of air with water was fatal, and, despite opposition of one branch of the theorists, a succession of "facts" appears to support that view. There have been recently, as some of our readers are no doubt aware, certain condenser tube failures of a very striking kind, of which the best explanation is based on the air theory. As far as our information goes, a certain condenser was fitted with new tubes and put into service. In seventeen days a group of tubes near the steam entrance were eaten through. Poor quality was charged against them, and they were replaced by tubes supplied by another firm. In the same number of days those tubes also failed. The theory now propounded is that it is not the tubes but the design of the condenser that is at fault. The steam enters at a great velocity, the vacuum being high, through the usual expanding mouthpiece. On expansion, with the corresponding fall of pressure, air is liberated, and immediately attacks the tubes nearest the inlet. The air-theorists say now that the sudden expansion of the steam, owing to the bell mouth pipe, must be stopped, and that the steam must be deflected in such a manner that it cannot impinge directly on a relatively small group of the tubes. Quite possibly they are right, notwithstanding the fact that in all probability dozens of other condensers, working, as far as one can see, under identical conditions, are not nearly so troublesome. That kind of anomaly is familiar in corrosion research. If they are right, if it is proved by actual experience that a modification of the condenser will prevent the corrosion, we shall have yet another and a very striking example of the fact that simple observation of failures in practice has done as much and even more to prevent corrosion than the most careful scientific researches.

That the researchers have failed to help engineers materially in the reduction of corrosion must not be set down to their discredit. They have at least made it quite clear that corrosion is an extremely baffling phenomenon, and not one that the world can be accused of tolerating through gross neglect of efforts to remove it. We do not give up hope that, even yet, a general theory which will meet all the difficulties and dissolve all the anomalies may be found. The search for it must, of course, be continued, for in no single direction could such a saving of expenditure be realised as in the prevention of the rusting of steel structures without resort to the costly expedient of annual painting on which we are now forced to rely. The cost of such investigations is wholly insignificant in comparison with their potentialities, and they must therefore be pursued until it is clear that no further good can be achieved by their continuance, either because a general law or set of laws has been discovered or because we are forced at length to admit that the phenomena are too complex for human solution, and that our final resort must be to such empirical facts as we can derive from occasional cases.

The Indian Railway Administration Report.

Hitherto, the scope of the Indian Railway Administration's annual report—a copy of which for the year ended March 31st, 1922, has only recently come to hand—has not proceeded beyond the year under review. The Railway Finance Committee has, however, recommended, and the Legislature has confirmed, the introduction of a five-year forward programme for railway capital expenditure. The columns of the public Press contain ample evidence of the interest taken in this matter and of the urgent public desire that full advantage shall be taken of this important change to effect improvement with the least possible delay. It is, however, a matter of regret that public criticism in these matters too often seems to display a want of appreciation of the difficulties to be encountered, and of what is being done to surmount them. To a certain extent it is recognised that the public attitude in this matter has been due to want of information, and an effort to meet this need has, therefore, been made in this report. A special chapter has been introduced in which the main difficulties in passenger and goods working, with which the public is principally concerned, are referred to, and a description of the remedies, both in hand and in prospect, is given. Throughout the report the review, under each heading, has further been extended to include both a description of what has been done and what it is hoped to achieve under the operation of the five-year programme of capital expenditure. As a result the present report, exclusive of its appendices, fills 70 pages, as against 54 pages a year ago.

Financial.

During the year 1920–21 the capital expended was 24.08 crores of rupees,* but during 1921–22 it was only 23.43 crores. It is explained that this fall was not due to any deliberate slackening of the effort to recuperate, but to the fact that the grant allotted for 1921–22 was 23 crores, as against a grant of 25½ crores in the preceding year. "In accordance with the old procedure, since discontinued, the coat had to be fashioned with the cloth available." Of the 23.43 crores, 11.28 crores went in improvements on existing lines, 10.04 crores on rolling stock and 2.11 crores on new lines.

In accordance with a resolution of the Legislative Assembly on September 13th, 1921, a Railway Finance Committee has been set up. It had before it on December 5th, 1921, that part of the Acworth Committee's report which recommended the complete segregation of the railway budget from the general budget of the country. It was considered that this proposal was outside the domain of practical politics in the existing state of Indian finance. The recommendation was, however, made that the question should be re-examined three years hence, when it might be hoped conditions would be more normal and that financial equilibrium would be re-established. The Finance Committee was, none the loss, greatly impressed by the evidence recorded in regard to the need of rehabilitation and improvement of the existing lines, and considered that, for that purpose, a guaranteed programme, extending over a course of years, was almost as important as the possession of larger funds. Two of the five recommendations made were (1) that money not spent one year should not lapse, and (2) that the programme for the next five years should be fixed at 150 crores. The Legislative Assembly accepted this recommendation, and the present report observes that it is impossible to overrate the importance of this decision as affecting railway development in India. For the first time railway administrations have now been placed in a position to plough ahead and to carry out their schemes of improvement with a full assurance of financial support. Moreover, the old obligation to spend the grant allotted within the year has now disappeared, and railways are at last in a position to order their outlay with due regard to the object to be attained without the constant fear of lapsed grants and subsequent withdrawal of resources.

It has hitherto been considered to be inconsistent with the ordinary scheme of Government finance to set aside money not actually required during the year. Thus no provision has been made for depreciation and renewals. The Railway Finance Committee considered this question also, and recommended that early steps be taken to calculate the rates of depreciation which should be allowed for the various classes of railway plant and material. This is obviously a matter of considerable technical difficulty, but measures have been initiated which will, it is hoped, provide a solution and, the report adds, "it may confidently be hoped that we are now within measurable distance of surmounting this last great difficulty in our railway financial arrangements."

Receipts and Expenditure.

The gross receipts for the year from the State-owned railways were 81.69 crores, and the expenditure 65.67 crores. The net receipts, 16 crores, were equal to a 2.75 per cent. return on capital, as compared with 5.58 per cent. in 1913–14. Other liabilities, such as interest on capital, annuities, &c., swallowed up 25.57 crores, and so, actually, there was a loss of 9.27 crores. It is observed that it would be futile to attempt to minimise the serious significance of these figures. For the first time since 1900 the railways have fallen from a status of an important source of revenue to the country, and are responsible for an addition of a very large amount to the annual liability of the Government. An examination of the conditions in other countries is made, and it is then said that it is apparent that India is certainly not alone in her railway difficulty and that, compared with the results which other countries have had to record, there is even some ground for congratulation.

The percentage of expenses to receipts was 51.79 in 1913–14, and had risen to 65.54 in 1920–21, and to 76.22 in 1921–22. Maintenance of way rose from 12.99 per cent. in 1920–21 to 15.43 in 1921–22; maintenance and running of locomotives from 22.70 to 27.37. An examination of the accounts show that the increase in way and works was, in the main, due to heavier renewals of rails, sleepers and bridges. The increase is, thus, the natural outcome of the effort being made to bring lines up to standard and, to this extent, it may fairly be hoped that it is temporary. In the locomotive expenditure the universal underlying cause was the high price paid for fuel.

This section of the report concludes by saying that every railway in India has now, under the Railway Board's instructions, adopted systematic measures, by means of retrenchment committees or other-

* 10,000 rupees is a lakh and 100 lakhs is a crore. The present value of the rupee is about 1s. 4¼d.

wise, to prepare and carry out a regular campaign of economy, embracing all avenues of railway expenditure.

Railway Materials.

After devoting a chapter to the railway staff, dealing mainly with the Indianisation of the railway services, attention is paid to the record total of 38.61 crores spent in 1921–22 on material, exclusive of coal, coke, stone, bricks, lime, ballast, &c., of which 27.88 crores were for imported materials. Of the latter sum 13.66 crores were for rolling stock, 8.25 crores for tools and stores, and 2.70 crores for permanent way material. Firms for building wagons—in particular the Indian Standard Wagon Company of Asansol—have been established in India, and now that, as announced on page 380 of our issue of October 7th, 1921, the Government of India has ordered that tenders for engines and locomotive boilers shall be invited in India, at least one firm is erecting works for locomotive manufacture, and it is hoped that the next annual report may be able to record some progress in the direction of making India independent in this important matter.

The report on this point makes some significant remarks which are best given *verbatim*. They are:—"There is one important point in respect of this matter which must not be lost sight of. If railways are to be worked economically in the best interests of the tax-payer, it is essential that they should buy their material in the cheapest market. Prices in England and other countries have fallen, and are falling rapidly, and if Indian-made materials are to take the place of supplies from abroad, it is essential that they shall be able to keep pace with this tendency. If this difficulty can be surmounted, there is no doubt that Indian railways will derive very important financial and administrative advantages. To mention only one point. The stores balances on State-owned railways were valued at the end of 1921–22 at the very large sum of 23 crores. It is probable that measures now being taken will enable this to be largely reduced but, even so, the balance which it is absolutely unavoidable to retain in reserve will be very respectably large, and must remain so until the enterprise of India's own manufacturers can put the country in a position to be independent of sources of supply 6000 miles away."

Rolling stock.

During the year 378 additional engines, 289 coaching vehicles and 6322 wagons were provided. A welcome change is the decrease in prices below the inflated level which followed the war period. Some of the latest orders in England have been placed at prices which compare very favourably with those which had to be paid twelve months ago. English-built standard wagons have been obtained for something in the neighbourhood of £340, compared with £750 quoted in the last report. The cost of a modern type powerful superheater engine has now reached the comparatively reasonable figure of £7500, as against £11,000 mentioned in the last report.

The five years' programme contemplated an addition of 942 engines, 6699 coaching vehicles and 32,300 goods vehicles. These numbers were, however, based on a very high level of prices which were current when the programme was framed, and it now seems possible that, for the above reasons, they may be very substantially improved upon.

So far as engines are concerned, there is not much to report as to improvement in type. There were 151 engines fitted for oil-burning running on the North-Western Railway, and the Karachi district is almost entirely run with this type of engine. The Great Indian Peninsula Railway has also introduced a new type of oil-burning passenger engine.

In July, 1921, the Railway Board decided that it was desirable that the standard design for broad and metre gauge wagons and carriage underframes should be revised in the light of criticisms received from various quarters. The Indian Railway Conference Association thereupon appointed a committee which has submitted a report recommending 39 types of vehicles, including two petrol tank wagons, two cattle wagons and two vans for explosives. The feature principally studied by the committee was that renewable parts, *e.g.*, axle-boxes, draw-bars, buffers, wheels, brake-blocks, &c., should always be interchangeable between different types.

Inquiries have been made in Australia, and were to be made in America, as to automatic couplings.

We regret that our space does not permit us to cover the chapter on what had been done, and was being done, by the companies towards rehabilitation and development, nor the new one on traffic problems and remedies. The last chapter—general—mentions the establishment of a Central Advisory Council, as recommended by the Acworth Committee, and that steps have been taken as to the setting up of local advisory councils.

On April 17th the Parliamentary Secretary to the Ministry of Transport was asked a question as to when the transfer of the Ministry to the Board of Trade, as recommended by the Committee on National Expenditure, would be effected. Colonel Ashley replied that he could not say when this would be done.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MECHANICAL COUPLERS FOR INDIAN BROAD-GAUGE RAILWAYS.

Sir,—In your issue of March 2nd an article on mechanical couplers for broad-gauge Indian railways points out that the increase of train loads in India has rendered necessary the adoption of something stronger than the ordinary screw coupling at present in use. As the Government of India has had this subject before it for many years and now appears to be taking an active interest in it, further reference to the matter requires no excuse.

In referring to ordinary screw couplings the writer of your article was apparently unaware of the improvement effected in screw couplings during the last fifteen or sixteen years through the use of alloy steels. The original Yorkshire iron couplings adopted on the Indian railways have an ultimate strength of about 48 tons, but these, though they may not fracture, elongate under severe conditions in such a manner as to cause them to become to all intents and purposes rigid links, thus rendering them quite useless as screw couplings. The alloy steel couplings, on the other hand, whilst of lighter design than the original couplings, have a specified breaking load of not under 100 tons, and their adoption has given most satisfactory results, the percentage of coupling failures being reduced in a remarkable degree on railways using them, although operating some of the heaviest trains in India.

The fact remains, however, that many of the railways continue to use Yorkshire iron screw couplings and others the "D" class steel screw couplings, which have an ultimate strength of about 70 tons. It is of interest to note that a coupling in Yorkshire iron is proof tested to 12 tons, in "D" class steel to 16 tons, and in alloy steel to 35 tons. It might therefore be contended that the necessity for the adoption of a stronger coupling on the majority of Indian railways has not yet been disclosed. Notwithstanding this, certain authorities contemplate with equanimity the expenditure of the large sums of money which would be involved by changing the type of coupling in universal use on broad-gauge lines in India.

It can be argued that an alloy steel coupling is more expensive than the Yorkshire iron or "D" class steel one, but a comparison of the effective strength of the couplings would appear to answer such a contention. The alloy steel coupling as at present designed has an ultimate strength of as much as 110 to 120 tons, but it does not necessarily follow that this is the maximum strength possible, and something considerably higher may yet be obtained without an undue increase in cost or weight. The substitution of a new type of coupling on Indian railways will bring its own peculiar troubles, and these during the transition period are of a formidable nature.

It is most unlikely that, in view of the cost of such a substitution, the financial authorities would approve it during a period of financial pressure, and even without such pressure it does not appear wise that they should do so until all other alternatives have been fully considered and their possibilities definitely determined.

There may be other grounds on which an automatic coupler could be advocated, and, assuming them to be sound, it does not of necessity follow that this should be of the buffer coupler type. It should not be impossible to devise a coupler to take pulling strains only, to couple automatically within the limits of an M.C.B. coupler, and to fit it in conjunction with the side buffers at present in use, thereby retaining the good features of both systems.

The illustrations accompanying your article are of interest, showing an adaptation of an M.C.B. type central buffer coupling fitted to four-wheeled wagons for experimental purposes. At the same time they clearly indicate some of the trouble to be anticipated on account of any drastic change in the type of coupling now in use.

(1) During the transition period in place of any saving in the tare weight of the wagons an additional and self-contained buffer coupling may have to be carried.

(2) During the transition period an additional cost will be involved on the wagons.

(3) Reduced efficiency in operating will result.

(4) The central buffer coupler will be fitted below the frames of the wagons, so as to admit of the present coupling being retained during the transition period.

(5) An additional risk of accident will be involved during the transition period.

It is not suggested that passenger trains should be run of a weight of 3000 tons or that a great reduction to repairs or renewals on passenger coaches will result, or that the present couplings have proved unsatisfactory on passenger coaches, or that there would be any saving in operating time on passenger trains, or that the present coupling is not a tight one when used on passenger trains. In other words, the present couplings have given reasonable satisfaction on passenger trains, and it is on account of goods trains alone that a new coupling is advocated.

The fourth item is the most interesting to the engineer, and the application shown is not one which will meet requirements for a standard coupling on all wagons running on Indian broad-gauge railways, as the adaptation shown could not be used on Indian bogie stock where there is insufficient room between the headstock and bogie headstock or between the underframes and the bogie frame. When couplings are standardised the height of the centre line must be the same for all wagons.

The goods wagons in use in India are generally of the four-wheeled type with some 3000 bogie wagons, whereas those in use where the M.C.B. coupling has been adopted are with few exceptions of the bogie type. There are not many railways on which mixed bogie and four-wheeled stock trains are so fitted, and an investigation of them will not give much encouragement. Satisfactory results have been obtained, but at considerable expense, and complicated subsidiary devices have been adopted. The cause of this is the divergence of the centres of the couplings on passing over curves, and more particularly in passing over cross-overs, from the centre line of the permanent way. In sidings transition curves and straights between reverse curves are not necessary and, moreover, cannot always be provided.

For the above reasons it will be appreciated that the side clearances for movement required on couplings in India are considerably in excess of those provided in America; but even with the clearances required in America it is obvious from the tendencies of design that there is a well-defined requirement for more flexibility on M.C.B. equipments even when these are fitted to bogie wagons.

It is realised by engineers and is indeed obvious that the position of the centre buffer coupler on American rolling stock, whereby the buffing and draw-bar stresses are concentrated below the centre line, is not a satisfactory one, and that the draw and buffing forces should be transmitted to the underframes at or about the centre line of the frame depending on the particular design of wagon. The proportion of wheel base to length of wagon of the four-wheeled stock under consideration is such that heavy compressive stresses are occasioned to the solebars and longitudinal members by the loaded body, and these stresses will be greatly accentuated by slinging the buffer coupling below the underframe. Nor is it apparent how this can be obviated during the transition period, and what is done during this period will tie the hands of the railway engineer for the future.

Provided the existing Indian wagons are not unduly strong in the underframe, and no one with experience in their maintenance would suggest that they are, they are totally unsuited to transmit heavy buffing and coupling stresses applied to them from below the headstock and under such conditions would crumple up. Wagons to take heavy buffing shocks through the centre of the headstock must be designed to do so, and economically their strength will depend on the central longitudinal members, which, in the case of four-wheeled stock, must be rigidly attached to the solebars which carry the axle guards.

It is of interest to note that the M.C.B. type of buffer coupler is admitted to be not an ideal one, and it should be further admitted that the method of carrying it on American railways is quite unsuitable to Indian railways, both on account of the type of wagons in use there and the details of their construction. Once this fact is realised the position assumes a new aspect, and new zest will enter into the quest for a modification of the existing coupling to meet future requirements or the evolution of a new buffer coupling to meet the special requirements of Indian railways.

X.

April 19th.

INFORMAL MEETINGS.

Sir,—A recent development in the activities of the leading engineering institutions in London has been the introduction of the "informal" meetings, at which subjects of general interest to engineers are debated with freedom and vigour. The popularity of this type of meeting as a supplement to the regular general meetings has been very marked in the case of both the Institution of Mechanical Engineers and the Institution of Electrical Engineers.

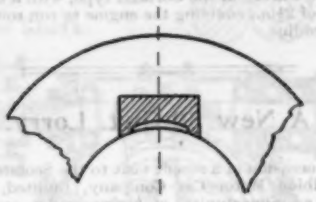
It seems strange, therefore, to find that the response to the enterprise of the Council of the Institution of Civil Engineers in following the lead of the younger institutions, by affording identically similar facilities, has so far been very disappointing.

Can it be true that there are only eight members sufficiently interested in a discussion on the electric lighting of railway carriages, or in it that the cloak of lethargy so long attributed to the Council of the Institution is really worn by its London members?

April 18th. Three of the Eight.

PROPOSED STANDARD KEYS AND KEYWAYS.

Sir,—In response to your invitation for comments upon the details published in your issue of the 13th instant, I would point



out that a saddle key is usually relieved in the centre as shown on the accompanying sketch, and not fitted to the shaft. This is the common practice in Lancashire, I believe, and is considered the only way of securing a safe grip with this key.

Dublin, April 21st. C. L. Sansom.

BOOKS RECEIVED.

Line Charts for Engineers. By W. N. Rose. London: Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 6s. net.

Factors in the Location and Lay-out of Locomotive Repair Shops. By H. L. Cole. Calcutta: Superintendent Government Printing, India.

Factors in the Location and Lay-out of Railway Repair Shops (Supplements). By H. L. Cole. Calcutta: Superintendent Government Printing, India.

The Phase-Rule and its Applications. By Alexander Findlay. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 10s. 6d. net.

Electric Cranes and Hauling Machines. By F. E. Chilton. London: Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, W.C. 2. Price 2s. 6d. net.

Belt Conveyors and Belt Elevators. By F. V. Hetzel, M.E. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 25s.

Industrial Mathematics Practically Applied. By Paul V. Farnsworth. London: Scott, Greenwood and Son, 8, Broadway, Ludgate-hill, E.C. 4. Price 8s. 6d. net.

Principles of Engineering Drawing for Technical Students. By Charles C. Leeds. London: Scott, Greenwood and Son, 8, Broadway, Ludgate-hill, E.C. 4. Price 10s. 6d. net.

The Generation and Utilisation of Cold. A general discussion held by the Faraday Society. London: The Faraday Society, 10, Essex-street, Strand, W.C. 2. Price 10s. 6d. net.

Elasticity and Strength of Materials used in Engineering Construction.—Section II.: Theory of Simple Flexure. By C. A. P. Turner. U.S.A.: C. A. P. Turner Company, Minneapolis, Minn. Price 5 dollars.

L. and N.E.R.—Three-cylinder Locomotive—Details.

Through the courtesy of Mr. H. N. Gresley, now chief mechanical engineer of the London and North-Eastern Railway, we are enabled to place before our readers to-day an exceptionally interesting Supplement, showing many details of his three-cylinder passenger "Pacific" express engine No. 1470. This engine was fully described in our issue of April 14th, 1922, and a general arrangement of it was presented in The Engineer of January 26th, 1923.

The detailed drawings are practically self explanatory, but a few notes about them may be welcome.

The connecting and coupling-rods are made of nickel chrome steel, heat treated, and show how well this material can be applied for making these parts very light without any sacrifice of strength. The steel has a tensile strength of 50 tons per square inch, with a minimum yield point of 80 per cent. of the tensile strength, equal to 40 tons per square inch. The carbon steel used for making such rods has a tensile strength of from 32 to 38 tons per square inch, and as the yield point is only 50 per cent. of the tensile strength, the effective strength is only from 16 to 19 tons per square inch.

The outside connecting-rod, shown on the drawing, is 11ft. long and weighs 324 lb.; a similar rod, only 3in. longer, used on another class of engine, but made of carbon steel, weighs 564 lb., so that the saving in weight is very considerable. The accompanying table gives figures from a test and an analysis of the nickel chrome steel used in the rods, which are made of a light Is ection with wide flanges and thin webs. They are machined to within ¼in. of the finished size before heat treatment.

Tests :—	
Length of connecting-rod	11ft.
Weight of connecting-rod	324 lb.
Yield limit, tons per square inch	48.4
Breaking strength, tons per square inch	58.0
Ratio, yield limit to breaking strength, per cent.	83.4
Elongation per cent. on 2in.	20.0

Analysis :—	Percentage.
Carbon	.33
Silicon	.21
Manganese	.60
Sulphur	.032
Phosphorus	.039
Nickel	3.42
Chromium	.60

The combined piston and rod is also made of nickel chrome steel, heat treated, in one piece, and the rod is hollow. After heat treatment and before machining to the finished size the bronze rim is cast on by a special process which makes a perfect union of the bronze to the steel. The design, as will be seen from the drawing, results in a piston of very light weight and simple construction.

The crosshead is of the three-bar type, and it will be noticed from the drawing that the top bar gives a very large wearing surface on the crosshead when the engine is running forward.

The trailing wheel arrangement has radial axle-boxes, outside the wheels, of the Cortazzi type, with a translation each way of 2½in., enabling the engine to run round curves of small radius.

A New 30-Cwt. Lorry.

On the occasion of a recent visit to the Scotstoun works of the Albion Motor Car Company, Limited, we were accorded an opportunity of seeing under construction and trial a series of the new 30-cwt. petrol lorries which the firm has recently completed for Government Departments and other contractors. Reliability furnished the keynote of the design, but considerations of weight and cost were also given careful attention, and we noted the free use of heat-treated alloy steels on important parts of the lorry which, while achieving lightness, do not sacrifice strength.

The general arrangement and appearance of the chassis is shown in the two views we give in Figs. 1 and 3. The main frame is of pressed steel, and both the longitudinal and cross members are heavily proportioned so as to give requisite strength and rigidity. We would particularly mention the very long and flexible springs, which, with solid tires, give good riding over rough roads. A Hotchkiss drive is employed on the rear springs, which take both the driving and braking torque and also the actual driving forces. Turning circles have been kept low—about 43ft. from centre to centre of the outside tracks, and a standard wheel base of 11ft. 3in. is adopted. On the ordinary models solid tires are fitted throughout. These are of 90 mm. section, single on the front wheels and twin on the rear wheels. Various other wheel equipments were seen going through the shops, including cushion tires, twin pneumatics on disc wheels for the rear pair, and giant pneumatics with a power type tire pump driven from the gear-box. Brief mention may be made of the front axle design.

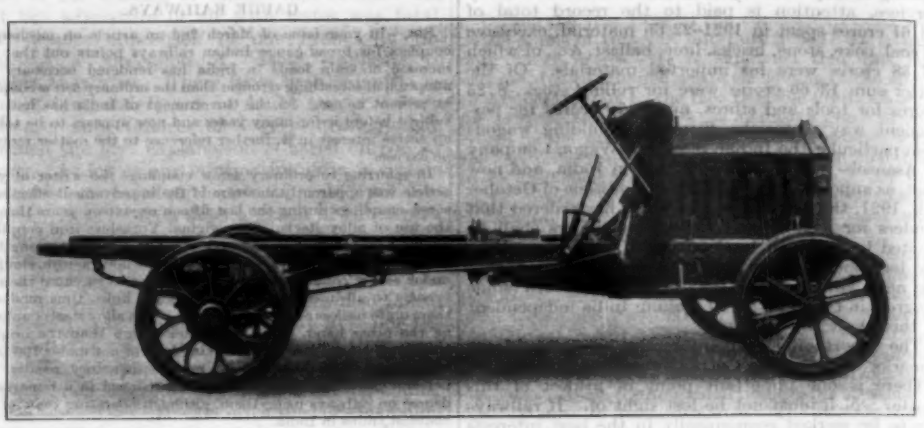


FIG. 1—CHASSIS OF NEW 30-CWT. ALBION LORRY

The axle itself is a high carbon steel drop forging, while the wheel bearings on the stubs are of similar material. The wheels are carried on plain white metal-lined bushes, which are lubricated from the oil reservoir in the hub caps.

We reproduce in Fig. 2 a sectional elevation of the engine, which is of the four-cylinder monobloc type.

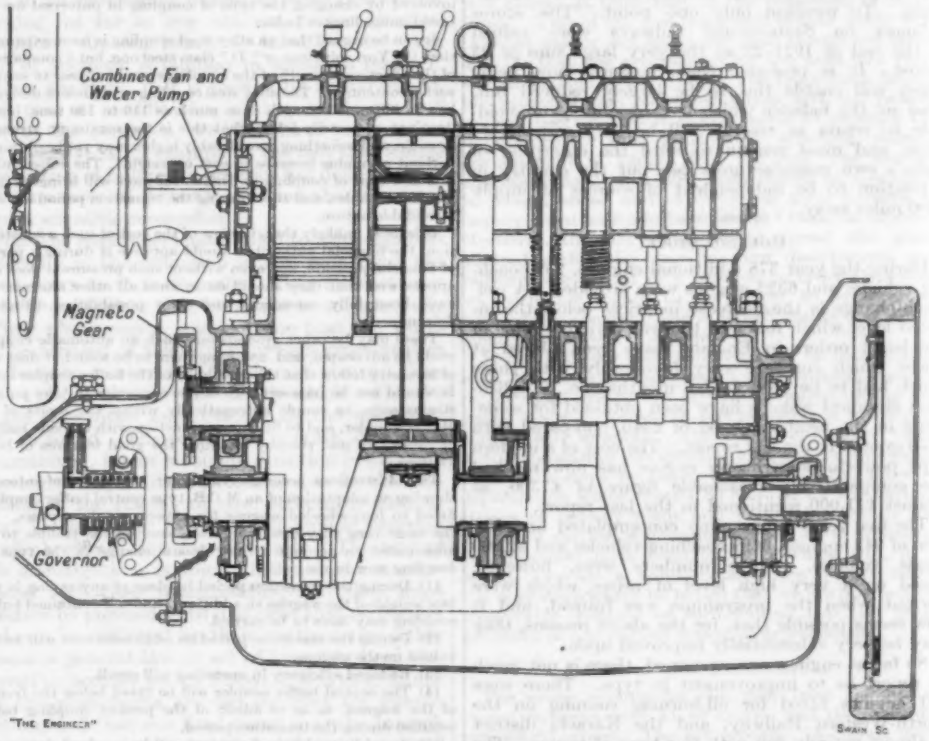


FIG. 2—FOUR-CYLINDER ENGINE FOR 30-CWT. LORRY

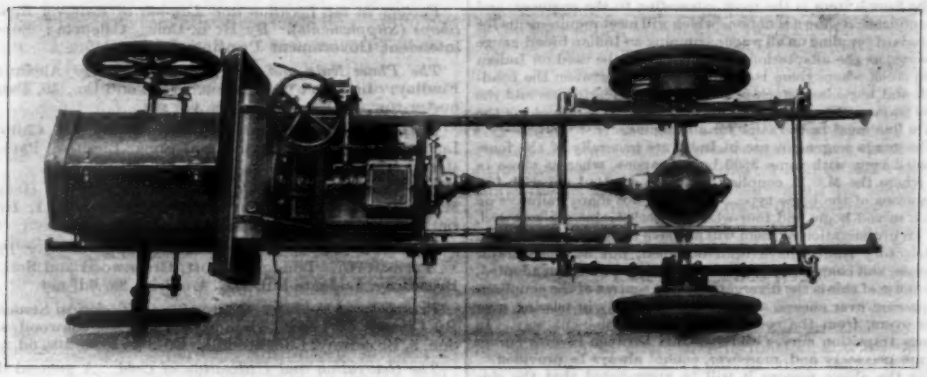


FIG. 3—PLAN OF CHASSIS OF LORRY

Incidentally it may be remarked that the Albion Company has for a long time made monobloc engines, and its 32 horse-power W.D. model is probably one of the largest monobloc lorry engines built in this country. The dimensions of the cylinders are 3½in. bore with a 5in. stroke, and the engine is designed to develop its full rated power at a speed of 1250 revolutions per minute. The cylinder head of the standard engine is in one piece—although a two-piece head is fitted to some models—and is secured to the cylinder casing by a large number of studs, to ensure an even bedding of the cylinder head upon the copper-asbestos joint. The cylinder casing is attached to an aluminium crank case made in two main parts, the upper and the lower, with a horizontal joint between them. At the front of the crank case is the governor and cam wheel casing, which forms a third part and carries the bearing for the starting handle. The arrangement of the governor and the gear wheels driving the cam shaft and magneto is shown in the drawing reproduced. The crank shaft is carried in three long bearings with bronze white metal-lined bushes, which are fixed to the upper portion of the crank case, so that when the lower portion is removed for examination or cleaning, the crank shaft and its bearings remain in position undisturbed. The cam shaft is also housed in the crank case, and cam rods, guided in vertical bearings, operate the suction and exhaust valves which are grouped alongside one another. Pistons of a light and neat design furnished with three piston rings are used, and arrangements are provided for lubricating the top end of the connecting-rod by means of the oil scraped by the piston from the surface of the cylinder, which finds its way through holes in the piston to a flat along the gudgeon pin. The large ends of the connecting-rods are made in halves, and lubrication is effected by means of centrifugal throwers attached to the crank webs. Lubricating oil is fed to the throwers and to all main bearings, the cylinders, and the magneto spindle by a mechanical lubricator of the Albion-Murray patented type. This lubricator is fixed to the offside of the engine and is worm driven from the cam shaft. In it a rotating cylinder fitted with a plunger rotates within a series of suction and delivery ports, the plunger stroke being produced by a stationary circular cam fixed in the upper part of the casing. A spring forces the plunger head against the cam. By this means a steady feed to twelve individual points is maintained. Two settings—maximum and minimum—are provided for various duties, and the pump delivery may be accelerated by hand operation, if required. Oil passes through the engine only once and is then drained off at the sump. Any possibility of bad wear of bearings arising from crank case oil dilution is thus precluded.

Other points of interest in the design of the engines are presented by the carburetter, the ignition system and water-cooling arrangements. The carburetter is a special Albion Zenith type with a hot air intake, the mixture being carried across the engine in a cast iron pipe passing through the water jacket. Between the carburetter and the inlet valves a valve controlled directly from the

centrifugal governor on the front end of the crank shaft is placed. The whole of the connecting linkage between the governor and valve is enclosed and so arranged that any departure from the original adjustment is not possible without partially dismantling the gear. This patented sealed governor is a feature of the latest Albion models, and one on which the makers lay considerable stress. The magneto drive is taken from the crank shaft train of gears at a point on the near side of the engine, and a special flexible coupling is interposed between the gear shaft and the magneto spindle. This coupling is simple in design, and consists essentially of two equal flanges each provided with a driving pin. Leather links connect the two driving pins and form a coupling silent in operation, which eliminates any small inaccuracy in the alignment of the magneto and its driving spindle.

A special feature of the water cooling system is the combined air and water circulating fan—shown in Fig. 2. This system of cooling was first introduced by the Albion Company and has been used by them since very early days. The pump bracket is fitted directly on to the cylinder casing and the pump works in the water space, the condition of which is readily ascertained when examining the pump. The common spindle is belt driven, and the fan pulley also carries a pulley from which the lighting dynamo is driven.

The arrangement of clutch used is the Albion-Murray patented single dry plate clutch, which is illustrated in Fig. 4, and also in part in Fig. 2. The friction lining is riveted directly to the engine fly-wheel, to which also the outer clutch cover is bolted. This plate is furnished with six spring caps, which enclose and guide the clutch operating springs. The driven pressure plate has also a friction lining, and it is provided with six centring pieces which enter the springs and guide them, allowing the pressure plate to rotate with the cover and move in a fore and aft direction. Withdrawal of the clutch is effected by means of a foot pedal which operates through a ball thrust bearing muff. A small drum attached to the clutch shaft serves as a clutch brake, the rim of the drum coming in contact with a lever faced with a friction-lined pad when the foot pedal is fully depressed. A gear-box having three forward speeds and one reverse is provided. The special ball-thrust bearings on the main shaft in the gear-box may be noted. The speed reductions are first and reverse speeds 4.22, second speed 2.02, and top speed or direct drive 1.00. Both foot and hand brakes are fitted, the former consisting of brake shoes of the external contracting type operating on a drum fixed to the rear end of the gear-box main shaft. The drawing reproduced in Fig. 4 shows one of the hand brakes on the rear axle. These brakes are lever operated and expand internally in a steel drum. Further illustrations in Fig. 4 show the cardan shaft and front and rear joints, which are of the Hooke type with hardened steel bushes. The cardan shaft is splined at both ends, and the sliding motion on the rear axle is taken up by the splines in the forward joint. We reproduce drawings of the worm drive and the arrangement of the differential and rear axle drive. The worm drive is designed in a series of four possible ratios, one of which may be selected to suit the service conditions. Both the differential and the worm shaft run in ball bearings, while the wheels are carried on plain bearings with white metal-lined bushes which, like the front wheel, are lubricated by oil from the hub caps. The axle body is machined from a solid nickel chrome steel forging, and it will be noted that the design of the two-pinion differential and the axle shafts is such that these may be withdrawn without interfering with the differential gear.

The lorries we saw under test ran well, and the clutch action was particularly good with no trace of stagger when the clutch was engaged.

The model we have described was shown at the Scottish Motor Show in Glasgow.

Extinguishing a Burning Oil Well.*

POTRERO No. 4 is well known as one of the largest of the enormous producers of Mexico, having given over one hundred million barrels of oil before salt water appeared.

The career of the well was an eventful one; it was brought in uncontrolled in December, 1910, brought under control in March, 1911, developed large seepage areas in its vicinity early in 1914, caught fire in August of that year, was extinguished early in April, 1915, produced under partial control for nearly four years, until December, 1918, when its production turned to an emulsion, which continued until April, 1919, when the well was finally closed in.

At the time oil was encountered no drilling valve was on the well head, and the bailer was being used; this was thrown clear of the well, and the oil rose to a height of some 250ft., whilst spray and gas went considerably higher. Vegetation for a radius of about a mile quickly became covered with oil. The well was then flowing at the rate of 100,000 barrels in twenty-four hours. The Buena Vista River, which flows near the spot, is the natural drainage for the area where this well is situated, and it was down this stream that immense quantities of oil flowed and were burnt many kilometres away.

Owing to the great pressure and volume of oil no ordinary method could be used to close the well; finally, however, an appliance, now fairly well known under the name of a "Bell Nipple," was devised and successfully installed, while a stronger design was made and successfully applied to the well in March, 1911; and those in charge were enabled to entirely close in production.

The well produced from the time it was controlled until August, 1914, a period of two years and five months. To meet the requirements of the Pipeline Department, a valve at the well head was opened and shut as was necessary to effect this.

In order to safeguard the well to some extent a small concrete house was built over the well head, steam pipes were put into the interior of the house so that in times of lightning storms, the well head could be completely surrounded by steam. Subsequently the small house was filled in with reinforced concrete, leaving merely an aperture through which the valve spindle could be worked. At this time active seepages began to be observed over a large area in the neighbourhood of the well.

On and about the middle of 1914 a lightning flash set fire to the gas escaping from the well; this gas fire melted some lead gaskets in the joints of the flow line near the well head. The oil from these joints caught fire, also the oil leaking from the bell nipple; the fire rapidly spread to the seepages and very quickly this large area was completely involved.

One of the effects of the fire was to cause considerable leakage at the bell nipple; why this was, it is difficult to say, but it was possibly due to the distortion of the rods and guys owing to the intense heat. The flanged joints at the valves, both on the bell nipple device and on the flow line, also started to leak and added their share to the fire. Measurements made after the fire was extinguished showed that the total leakage from the well head, that is from the bell nipple, from flanged joints and other connections, amounted to a total of over 18,000 barrels daily. The flow line from the well to the storage tanks had been buried a short distance from its connections to the well up to the storage tanks, and through this line the well produced 20,000 barrels a day uninterruptedly throughout the duration of the fire, the passage of the oil no doubt keeping the pipe cool enough where it passed through the fire to prevent it from being materially damaged.

Immediate steps were taken to combat the fire; batteries of some sixty steam boilers were erected in the vicinity, and steam pipes led as close as possible to the fire. An earth bank was also built round the main fire at the well. Gradually the limits of the earthen bank were little by little pushed in and the height raised to about 19ft. The fire was thus enclosed within an irregularly shaped crater, and it was decided to make an attempt to extinguish it by the use of quantities of foam-producing material, assisted by the full capacity of the steam and water plant.

The attempt, however, was quite unsuccessful, mainly owing to the immense quantities of gas being given off from the well. And it was decided to still further reduce the size of the crater by pushing in the banks, to fill in the crater with rubble to a considerable height, and, by the insertion of more pipes through the walls of the crater, withdraw such quantities of oil that only gas should remain burning on top of the level of the rubble. The rubble was also effective in preventing the burning oil, issuing under pressure from the different leaks in the well head, from jetting into the air. These operations were carried out, and in about twenty-four weeks from the outbreak of the fire, it had been controlled to the extent that only gas was being burnt.

Whilst the work of controlling the fire by earth banks was being carried out, many other schemes for shutting in the well had been considered, and some tried without success. Finally, it was proposed to cover the rubble with thin steel plates fitted with stand pipes, to insert a number of pipes into the rubble well above the oil level, and then to cover the plates with a thick layer of clay. After some weeks' work this plan was carried out, and by March, 24th, 1915, the fire was totally extinguished. The mound was subsequently covered with reinforced concrete.

* From a paper read before the Institution of Petroleum Technologists by Mr. A. E. Chambers.

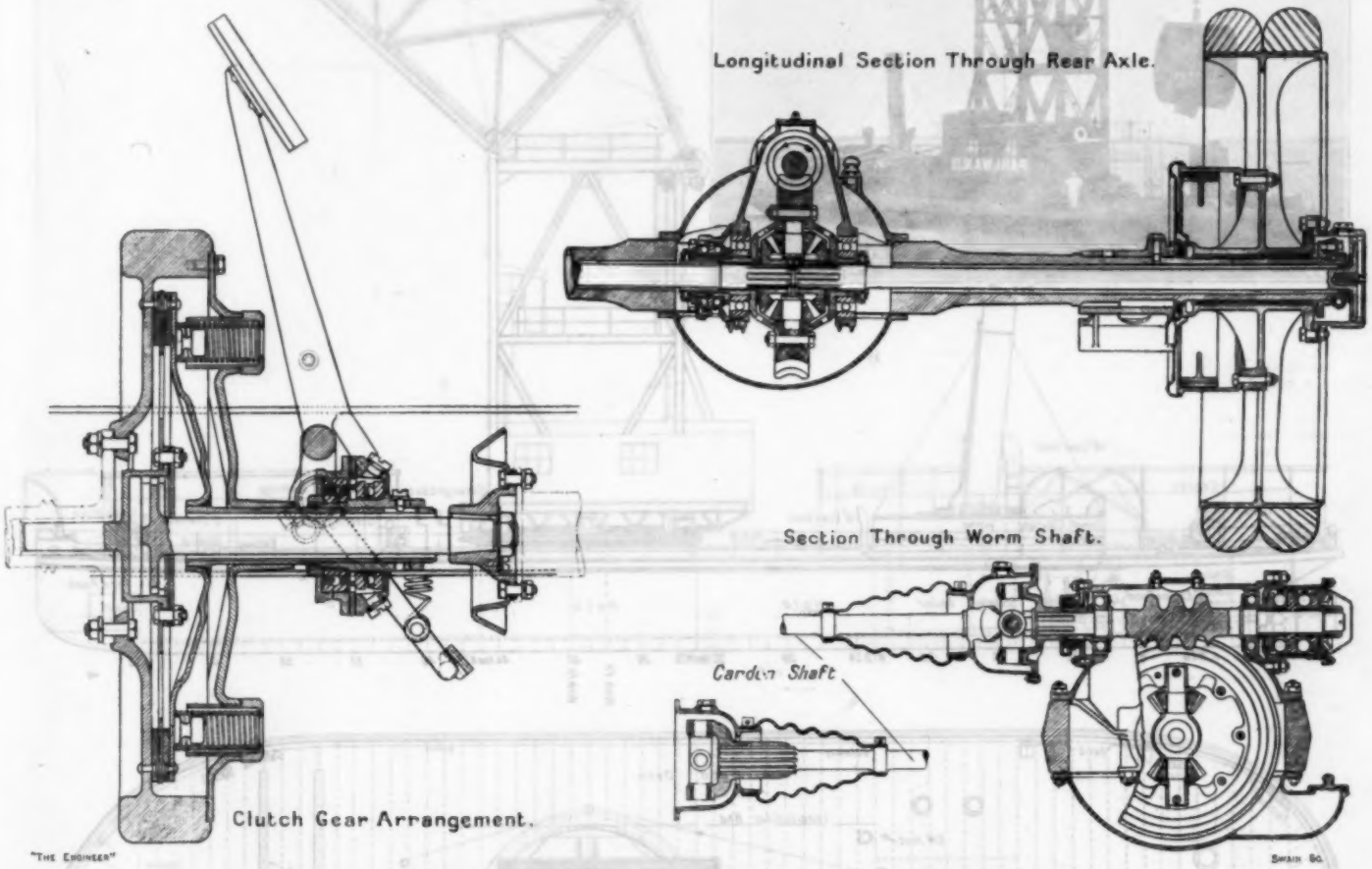
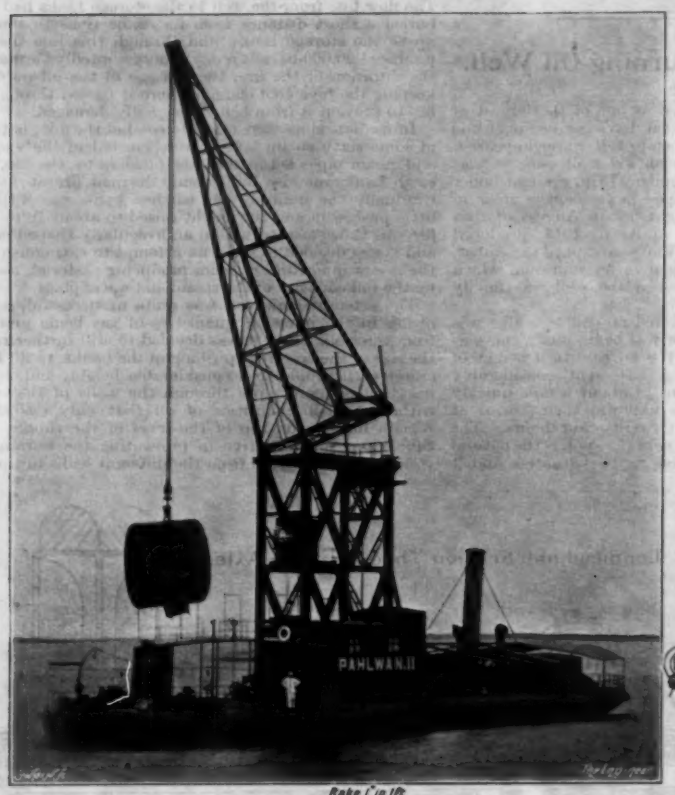


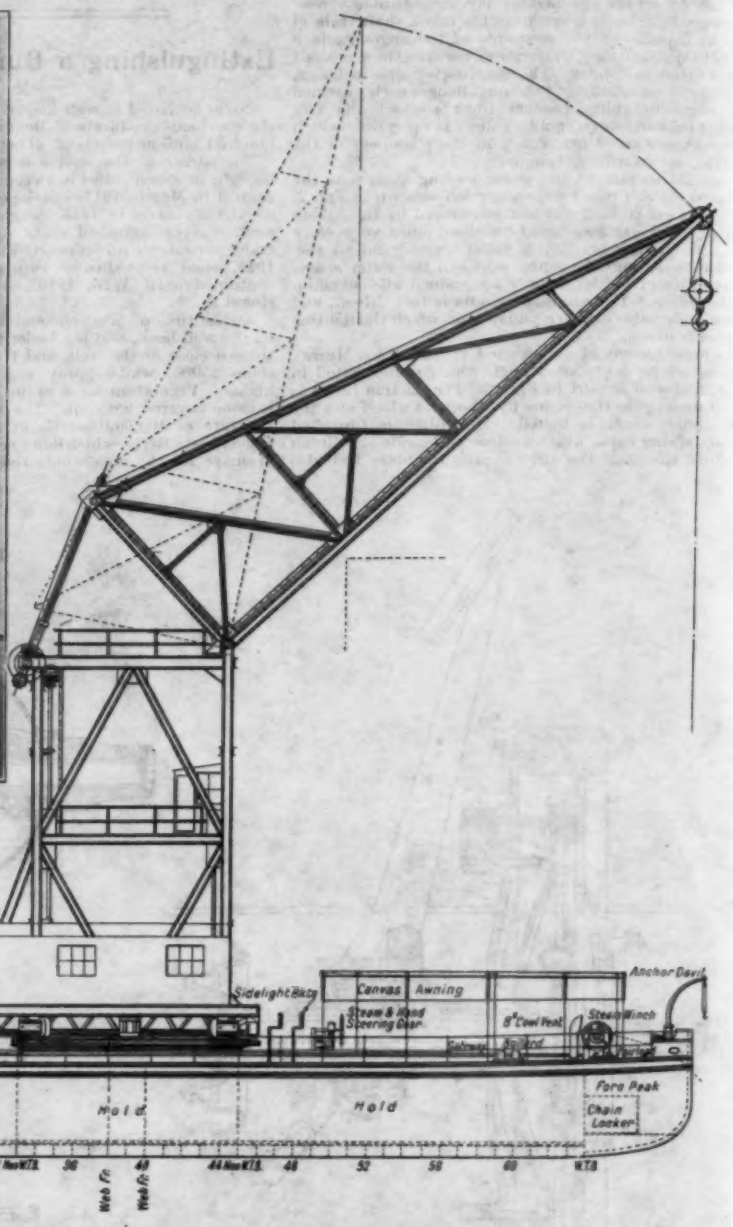
FIG. 4 ARRANGEMENT OF CLUTCH, CARDAN SHAFT ENDS, AND REAR AXLE DRIVE

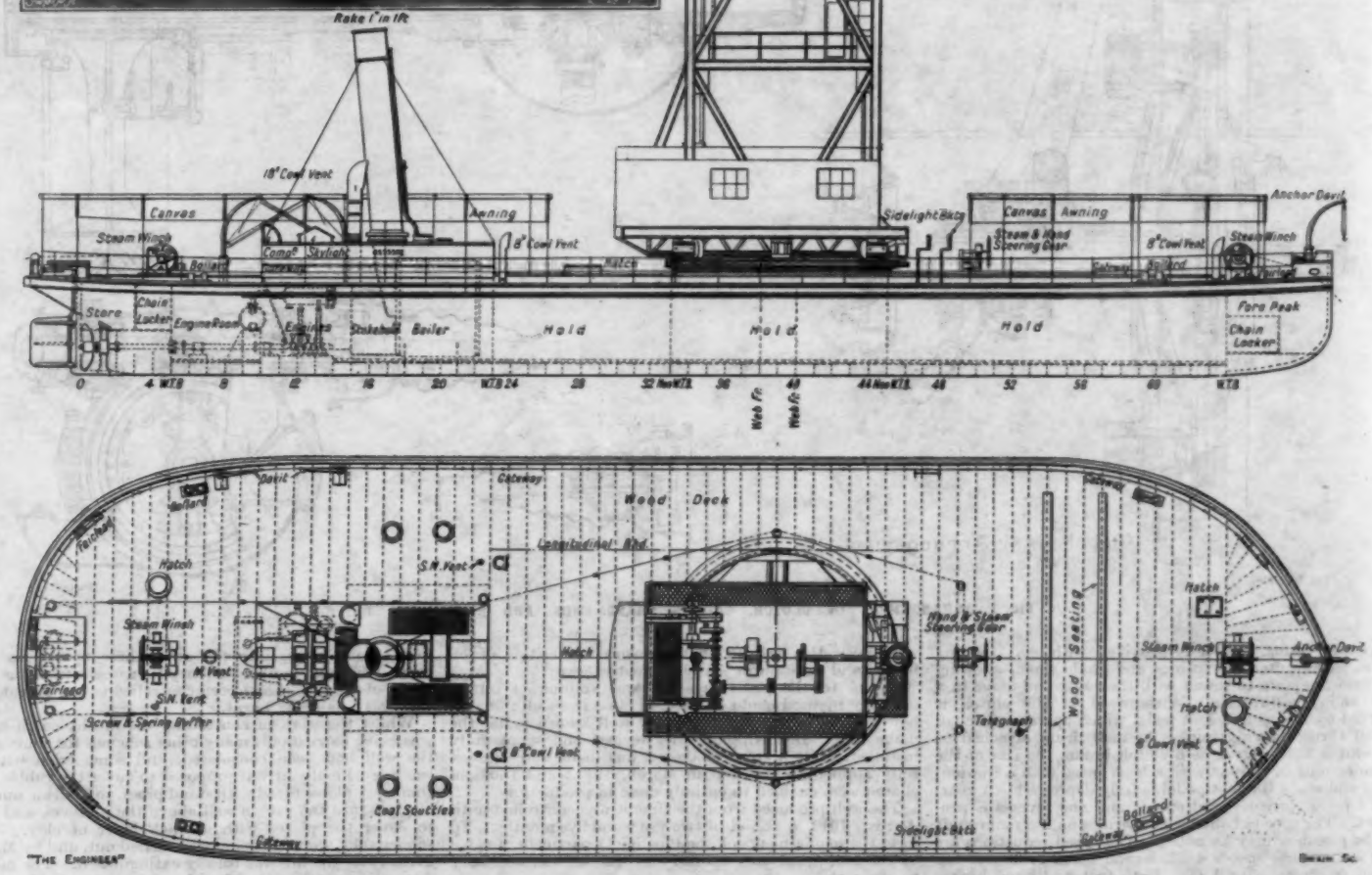
At the valedictory joint meeting of the proprietors of the South-Eastern and Chatham Railway, Mr. Cosmo Bonsor, the chairman, referred to the former unpopularity of those two railways, and how they furnished many a joke for the pantomime and music hall. He said that the late Lord Burton, a director, was very sensitive about these complaints, and, without consulting the officers, he borrowed an engine from the Caledonian. As soon as it arrived, the engineer said that the road and bridges would not take it, and the locomotive superintendent said there was not an engine turntable that would hold it. Mr. Bonsor said the locomotive had to go back, but "it had done its job. It brought home to the directors in the most emphatic manner the work that they had to tackle." Mr. Tempest had just been appointed the engineer, and he undertook the job. Four tunnels were widened, the whole of the main line was relaid with heavier rails, the shingle ballast was replaced by Kentish stone, and 588 bridges were strengthened. The work cost one million pounds, and was finished in 1913.

30-TON SELF-PROPELLING FLOATING CRANE FOR KARACHI

MESSRS. RENDEL, PALMER AND TRITTON, LONDON, ENGINEERS







30-Ton Floating Crane for Karachi.

THERE has recently been constructed for the Karachi Port Trust the 30-ton floating crane which is illustrated herewith. The crane, which is of the self-propelling type, was built to the specification of Messrs. Rendel, Palmer and Tritton. The contractors-in-chief were Ferguson Brothers (Port-Glasgow), Limited, who were responsible for the dimensions of the vessel, angles of heel with load on and off, crane, &c., and who built the hull, while Sir William Arrol and Co., Limited, as sub-contractors, supplied the crane proper.

The specification of the consulting engineers provided that the beam should not exceed 43ft., exclusive of fenders; that the propelling machinery should consist of twin-screw engines, which would give the vessel a speed of about 8 knots; that the crane should have a luffing jib with an outboard reach of 40ft. at full load; and that the angle of heel of the vessel, when carrying 30 tons at maximum radius athwart-ships, should not exceed 5½ tons. As actually constructed the vessel had the following dimensions:—

	ft.	in.
Length overall	145	9
Length between perpendiculars	140	0
Breadth moulded	42	0
Depth moulded	10	0

Mean draught in working condition .. 6ft. from keel plate

The scantlings throughout are described as being suitable for the size and class of vessel to obtain Lloyd's Class "A 1 Crane Steamer," and need not be entered into in detail. The propelling machinery consists of two sets of independent compound surface-condensing engines with inverted cylinders, the working pressure being 120 lb. per square inch. The cylinders measure 11in. and 22in. diameter by 16in. stroke. The high-pressure valves are of the balanced piston type, while the low-pressure valves are of the flat-slide single-ported type. The engines develop 350 horse-power, and are guaranteed to be capable of propelling the vessel at a speed of not less than 7 knots. There is one boiler. It is of the Scotch multi-tubular type, designed for a working pressure of 120 lb. per square inch, and it measures 11ft. in diameter by 9ft. 6in. long. There are three corrugated furnaces, each 3ft. 3in. in diameter.

The leading particulars of the crane are as follows:—

Maximum working load	30 tons
Outreach from side of pontoon for 30 tons	40ft.
Height of lift above water level at 40ft. reach	80ft.
Range of lift below water level	25ft.

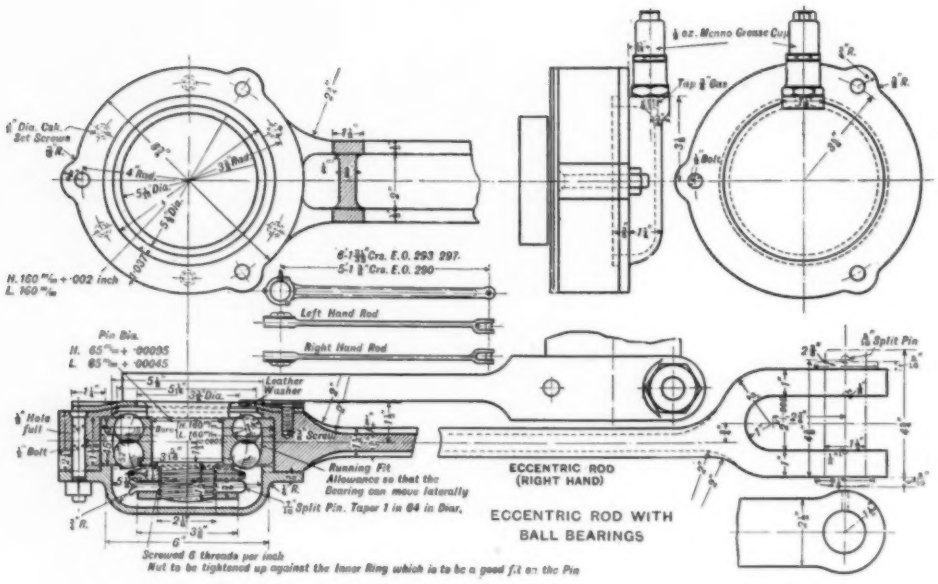
The motions of hoisting, derricking and slewing are all operated by steam power, and the speeds of working are:

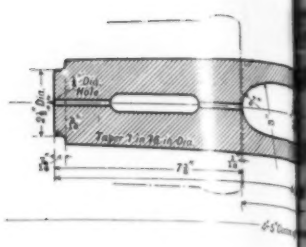
Hoisting, slow gear	30 tons at 20ft. per min.
Hoisting, fast gear	10 tons at 60ft. per min.
Slewing	30 tons, 1 rev. in 2 min.
Derricking	30 tons, full range in 4 min.

The engines, which are of the double-cylinder horizontal type, were designed for a working pressure of 100 lb. per square inch. They have cylinders with a 10in. bore and

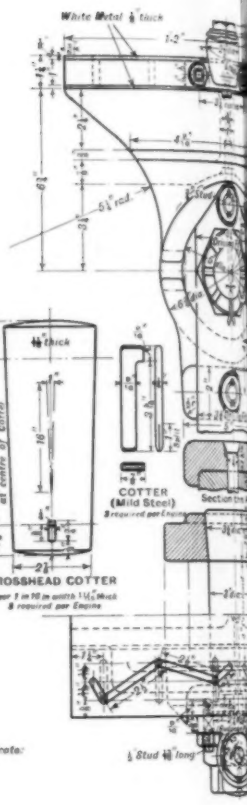
GREAT NORTHERN RAILWAY—THREE-CYLINDER PACIFI

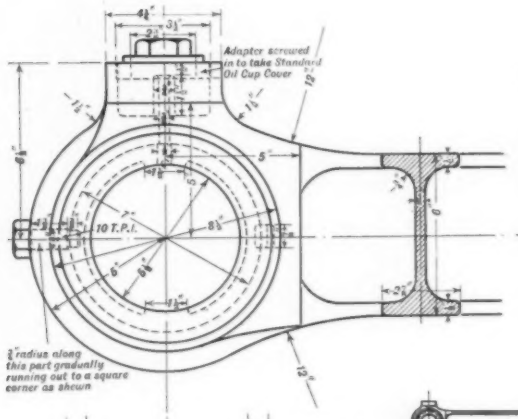
H. N. GRESLEY, M. INST. C. E., DONCAST

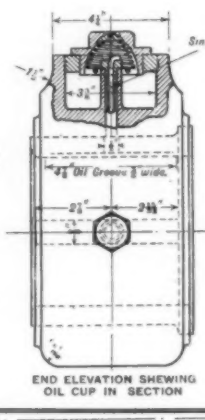

½ oz. Manno Grease Cup
Tap ⅜" Gas
Bolt
Left Hand Rod
Right Hand Rod
Split Pin
Leather Washer
Screw
Running Fit
Allowance so that the Bearing can move laterally
Split Pin. Taper 1 in 64 in Diar.
ECCENTRIC ROD (RIGHT HAND)
ECCENTRIC ROD WITH BALL BEARINGS
Screwed 6 threads per inch
Nut to be tightened up against the Inner Ring which is to be a good fit on the Pin



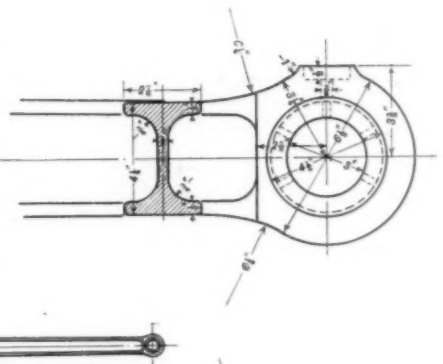
COMBINED PISTON & ROD (HOLLOW)
NICKEL CHROME STEEL

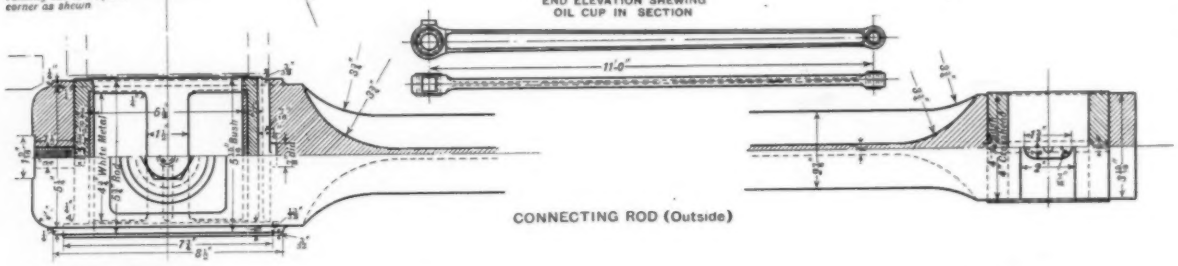



Adapter screwed in to take Standard Oil Cup Cover
10 T.P.I.
¾" radius along this part gradually running out to a square corner as shown

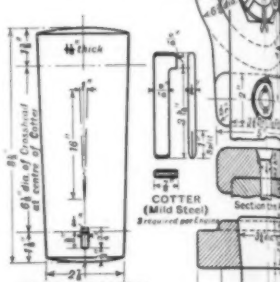


END ELEVATION SHEWING OIL CUP IN SECTION





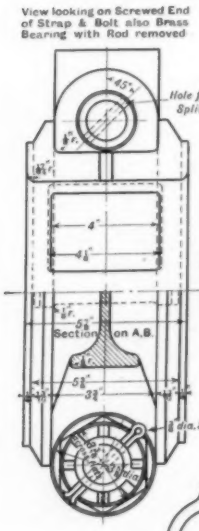
CONNECTING ROD (Outside)

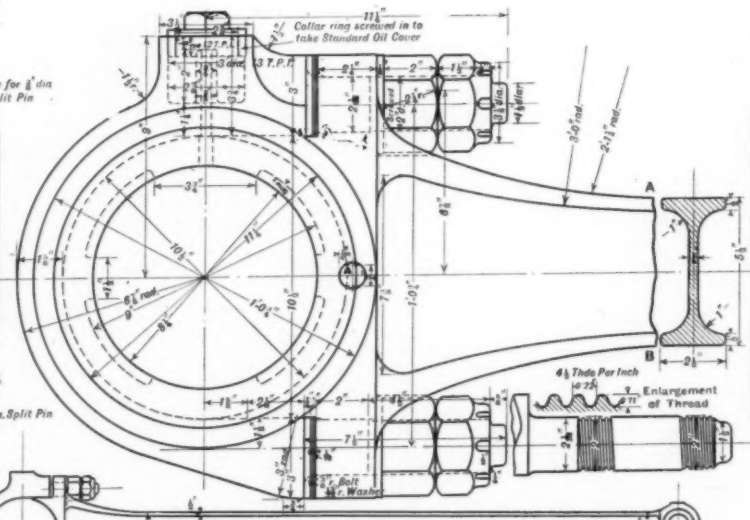


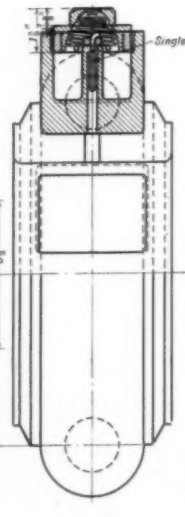
CROSSHEAD COTTER

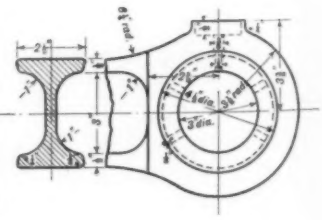
Taper 1 in 10 on width 1¼" thick
8 required per Engine

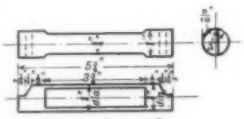
View looking on Screwed End of Strap & Bolt also Brass Bearing with Rod removed



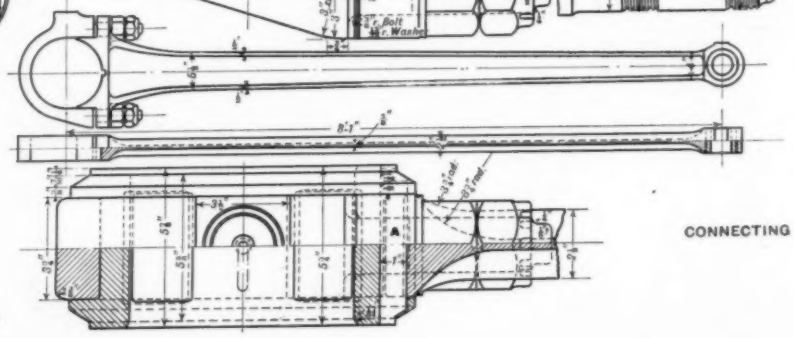




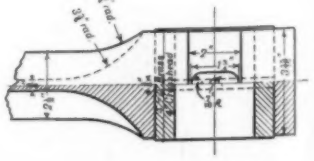




Detail of Key **A**

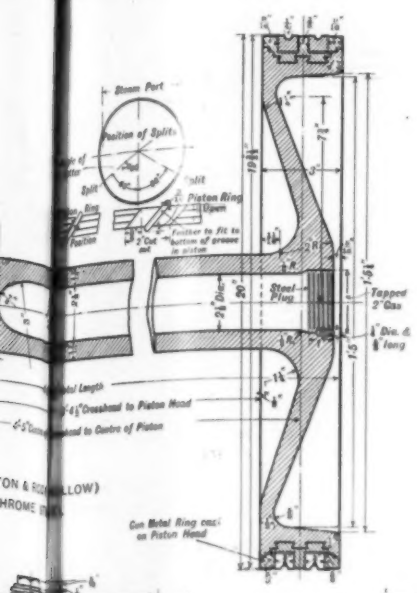


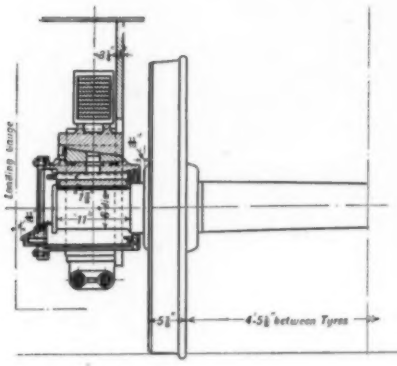
CONNECTING ROD (Inside)

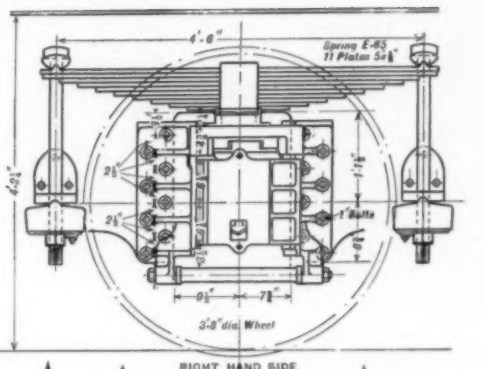


ER ACIFIC TYPE PASSENGER LOCOMOTIVE—DETAILS

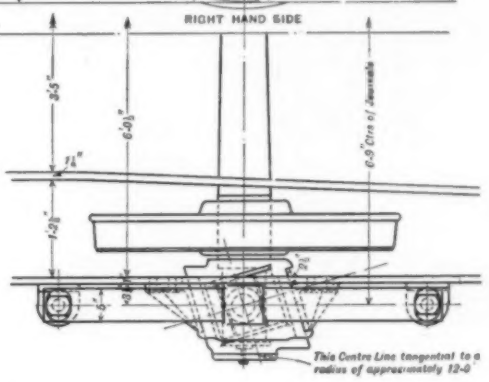
INST. DONCASTER, ENGINEER

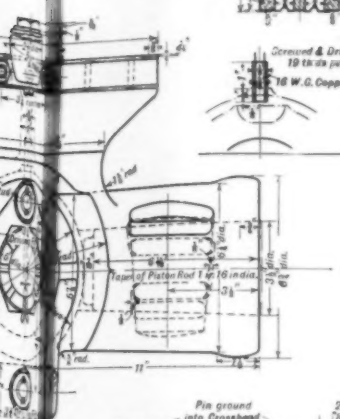


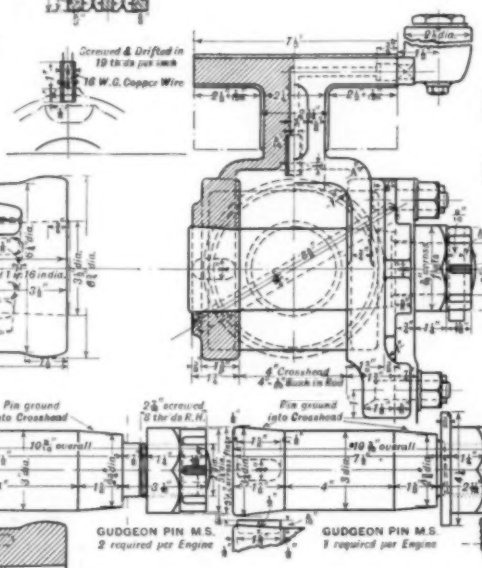


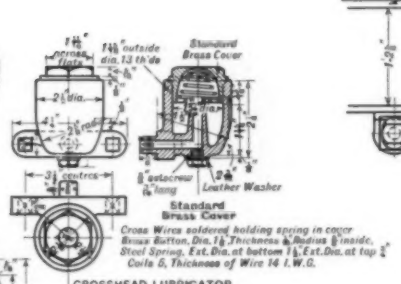


TRAILING WHEEL ARRANGEMENT



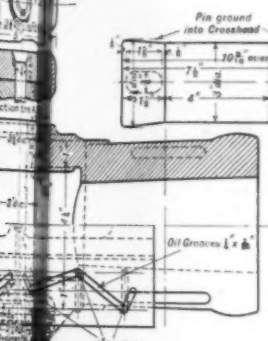



Screwed & Drifted in 19 thds per inch
16 W.G. Copper Wire
Crosshead Bush in Rod
Pin ground into Crosshead
2¾" screwed 8 thds R.H.
2" dia. screwed 8 T.P. inch R.H.
10⅝" overall
GUDGEON PIN M.S.
2 required per Engine
GUDGEON PIN M.S.
1 required per Engine


1¼" screwed thds
1¼" outside dia. 13 thds
Standard Brass Cover
2" dia.
3½" centres
½" autocrew ¼" long
2¼" Leather Washer
Standard Brass Cover
Cross Wires soldered holding spring in cover
Brass Button, Dia. 1⅛ Thickness ⅛ Radius ⅛ inside,
Steel Spring, Ext. Dia. at bottom 1⅛ Ext. Dia. at top ¾"
Coils 5, Thickness of Wire 14 I.W.G.

CROSSHEAD LUBRICATOR
3 required per Engine

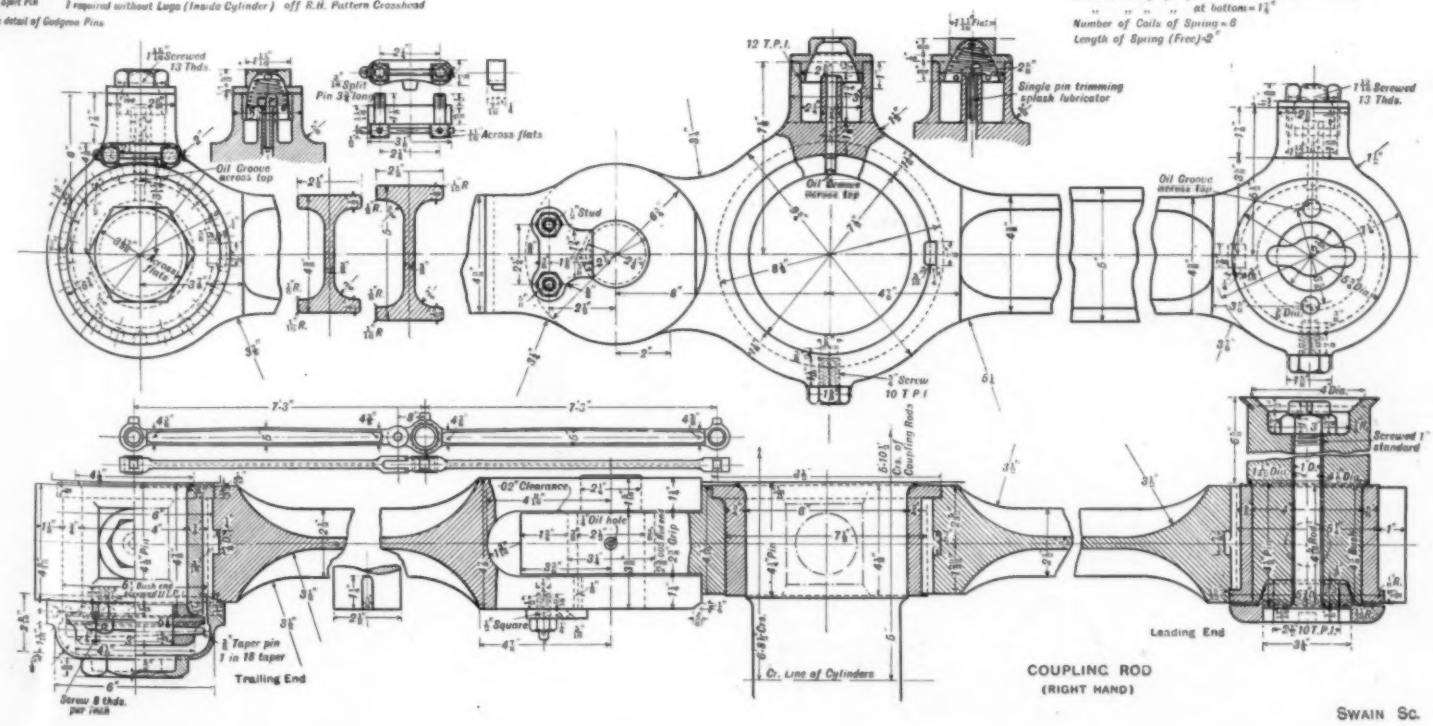
Bearing parts of Pins & Hexagonal Surfaces of Nuts to be potash hardened



CROSSHEAD

Split Pin — 2 required with Lugs (R.H. & L.H. Cylinder) Per Engine
1 required without Lugs (Inside Cylinder) off R.H. Pattern Crosshead
See detail of Gudgeon Pins

Particulars of Steel Spring with Brass Button
Thickness of Wire 14 I.W.G.
External Dia. of Spring where soldered on to Button = ⅝"
" " " " at bottom = 1⅛"
Number of Coils of Spring = 6
Length of Spring (Free) = 2"



COUPLING ROD
(RIGHT HAND)

SWAIN Sc.

a 12in. stroke, and are fitted with reversing link motion.

The roller-path of the crane consists of a heavily stiffened steel girder which supports a heavy steel billet machined on the face to form a track for the slewing rollers. The weight of the revolving structure is carried on eight large-diameter steel rollers fitted in pairs on bogies, one bogie being arranged under each corner of the superstructure. The latter is connected to the roller-path by means of a forged steel centre pin, which passes through a bearing carried by the superstructure, and is fixed in a socket attached to the centre pin girders, which are, in their turn, secured to the pontoon. The centre pin is bored for the passage of live and exhaust steam pipes. The superstructure is built up of rolled steel sections and plates, gusseted, braced and riveted together, and the base is arranged to carry the engines, the driver's cabin, and the gearing.

The crane is revolved by means of a pinion carried on the end of a vertical shaft supported in bearings on the countershaft, which gears with a circular rack on the outside of the roller-path. The upper end of this vertical shaft is driven by the engines through reductions of spur and bevel gearing. Double clutches are fitted so that the crane may be slewed in either direction without reversing the engines. The load is lifted on eight parts of best plough steel wire rope, two parts being wound on to a cast iron drum driven by the engines through three reductions of steel spur gearing. Two sets of gear of different ratio are provided for the first reduction to give the two speeds of working. The rope drum is turned and grooved and right and left-handed to take the full amount of rope at a single lap, and the rope is sufficiently long for three coils to be left on each end of the drum when the hook is in its lowest position. The load is sustained and controlled by a band brake which is applied from the operator's cabin. The hoisting gear is coupled up to the engines by means of a claw clutch. The snatch-block is furnished with cast steel sheaves bushed with gun-metal and mounted on a steel pin connected by steel links to a forged steel crosshead. The hook is mounted on a ball bearing.

The jib, which is built up of mild steel sections and plates riveted, gusseted and braced together, is connected to the superstructure by two steel pins fitted in bearings at the head of the superstructure. The jib sheaves are of cast iron bushed with gun-metal and mounted on fixed steel pins. The jib is moved in or out by means of two forged steel screws, which are furnished with a special form of thread, and which are made to revolve in phosphor bronze bushed nuts carried at the end of the jib ties. The screws are driven by the engines through reductions of spur and bevel gearing, and there is a claw clutch by means of which the gear is coupled up to the engines as required. A band brake, which is applied by a hand wheel and screw, is arranged to hold the jib in any position.

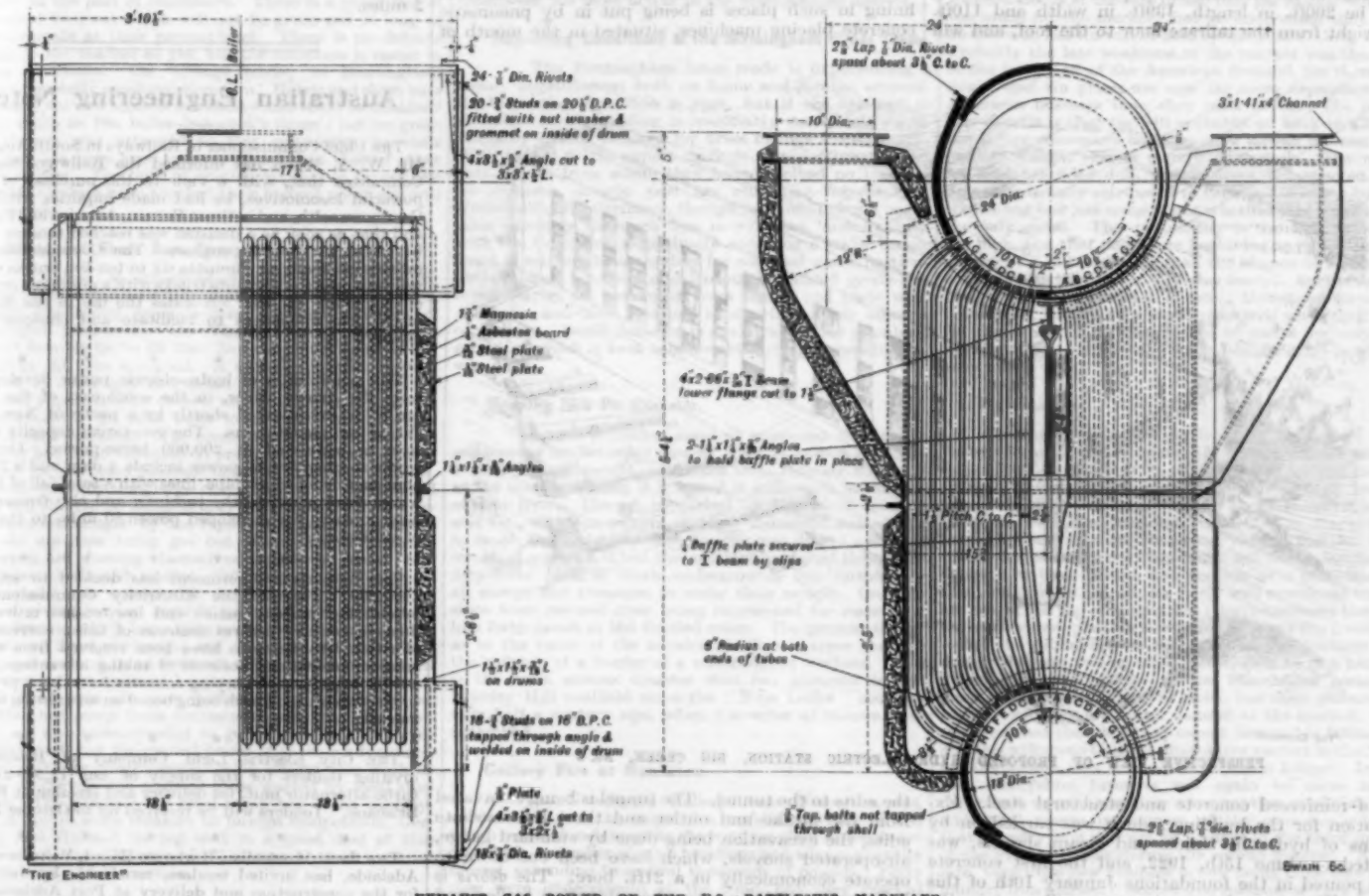
The machinery is enclosed in a steel-framed house covered with sheeting, painted, and made, as far as possible, waterproof. There are large windows on the front and sides. The levers for operating the crane are placed in the cabin side by side in such positions that they are under easy control of the driver.

The ballast necessary for the stability of the crane consists of scrap iron. It is carried in a tank on the tail of the superstructure. The test load had, according to specification, to be 25 per cent. in excess of the working load, and the half-tone engraving shows a test load of 37½ tons being lifted. It will be observed that the vessel is, apparently, on an even keel.

The deck of the pontoon is flushed from end to end and is boarded. There are two canvas awnings, one forward and one aft. A wire hand rail is taken right round and there are various bollards and fairleads for mooring and anchoring purposes. There are two steam winches, one right forward and the other right aft, and the vessel is furnished with hand and steam steering gear operable forward of the crane tower, engine-room telegraph, &c.

An Exhaust Gas Water-tube Boiler.

For several years past Diesel-driven auxiliary lighting sets have been used in naval vessels and have proved of particular service in effecting economy in fuel. Where such sets are used, it becomes possible to shut down the main steam boilers in port, and to rely on the Diesel sets for the supply of the necessary power and lighting. One drawback to this arrangement is that steam is often required in large quantities for secondary purposes. In the new United States Battleship Maryland this difficulty has been overcome by installing an exhaust gas boiler of the water-tube type in connection with each auxiliary Diesel engine. The complete installation is thereby rendered capable of supplying not only lighting and power, but also steam for oil fuel heating and for distilling fresh water. Some particulars of the special exhaust gas boilers designed for this purpose by Commander C. A. Jones, of the Bureau of Engineering of the United States Navy Department, were recently given by our American contemporary technical journal, the *Motorship*, and we reproduce herewith a general arrangement drawing of the boiler, which will be of interest to our readers.


3'-10½"
4"
C.L. Boiler
24 - ¾" Dia. Rivets
30 - ¾" Studs on 20⅝" D.P.C. fitted with nut washer & grommet on inside of drum
4x3½x½" Angle cut to 3x3x½ L.
17½"
6"
1½" Magnesia
1" Asbestos board
⅝" Steel plate
⅜" Steel plate
1½x1½x½" Angles
1½x1½x⅝" L on drums
18 - ¾" Studs on 16" D.P.C. tapped through angle & welded on inside of drum
18½"
18½"
½" Plate
4x3½x½" L cut to 3x2x½
18 - ¾" Dia. Rivets
"THE ENGINEER"
24"
2½" Lap ¾" Dia. Rivets spaced about 3½" C. to C.
10" Dia.
3x3·41x4 Channel
24" Dia.
12"
6"
4x3·66x½" I Beam lower flange cut to 7"
2-3½"x3½"x⅝" Angles to hold baffle plate in place
½" Baffle plate secured to I beam by clips
7½ Pitch C. to C.
6" Radius at both ends of tubes
16" Dia.
¾" Tap. bolts not tapped through shell
2½" Lap ¾" Dia. rivets spaced about 3½" C. to C.
SWAIN &Co.

EXHAUST GAS BOILER ON THE U.S. BATTLESHIP MARYLAND

It will be noted that the boiler has upper and lower drums connected by radially entering tubes, 424 in number. These tubes are 1in. diameter, and made of mild steel 9/$_{80}$in. in thickness. The total heating surface presented by them alone is about 445 square feet. The boiler is provided with a heat insulated steel casing, and provision is made for cleaning the tubes. When the engine is running under average load conditions, it is expected that from 400 lb. to 500 lb. of steam at a pressure of 10 lb. per sq. in. will be generated per hour. A test pressure of 50 lb. per square inch was used. Each engine exhaust pipe contains a by-pass arrangement, so that the boiler may be cleaned and overhauled without stopping the engine. Feed connections are taken from the main boiler feed range, and the steam drum is connected with the oil fuel heaters and the fresh water distilling plant in which the steam generated will be mainly consumed.

The Diesel auxiliary engines of the Maryland comprise two sets of Busch-Sulzer two-cycle six-cylinder engines, each developing 900 brake horse-power at a speed of 350 revolutions per minute. In service they will run at a normal speed of 300 revolutions, giving about 400 kilowatts at the generator. The engines will start up on Diesel fuel oil and after half an hour will be changed over to boiler oil, which may be regarded as the regular fuel. The two engines, along with the exhaust gas boilers, are accommodated in a water-tight compartment, the electrical generators being placed in a forward compartment and driven by shafts extended through the bulkhead. The electrical equipment, supplied by the General Electric Company of America, includes three wire generators giving 120-volt supply for lighting and 240-volt for power, along with balancing sets for voltage regulation.

CLEARING BESSEMER CONVERTER SPOUTS.

The method employed at the steel works at Senelle-Maubeuge and the Soudure Autogène Française for removing solidified slag from the mouths of Bessemer converters involves the use of an electric arc to split up the obstruction so that the separate parts are then easily removed by a bar. Metallic electrodes, about 1in. diameter and 3ft. long, are used, says the *Iron and Coal Trades Review*, the electrodes being coated with a special material which, on melting, yields a fluid slag which quickly cuts a channel through the obstruction in the spout. Direct or alternating current varying from 1500 to 2000 ampères, at a pressure of 100 volts may be used. The converter is turned on its side, and connection is established by means of a short piece of rail sunk in the plastic mass and connected to one terminal of the source of current. To the other terminal is connected the electrode, which is rather heavy, and, therefore, it is supported on a hand rail or other suitable object. The whole operation, requiring two men, takes from 25–30 minutes, of which 10–12 minutes are taken up by the actual cutting. This method leaves the lining of the spout undamaged, and so lengthens its life considerably. With the old method sometimes it required the consumption of from 3 to 4 tons of coke to soften the slag, so that it could be detached. Moreover, it took at least two hours to accomplish. The temperature required was so high that the siliceous slag attacked the magnesite lining.

The Société de Senelle-Maubeuge estimates that from 60–70 tons of coke are saved per month. The electrical equipment is simple, step-down transformers for three-phase, or motor generators for direct-current being employed. The outlay is moderate, and the plant quickly pays for itself.

A VISION OF TERROR.

In the *Practical Engineer* of May 3rd will appear the first chapter of a very remarkable serial, which has been expressly written for that paper. The object is to present a picture of naval and aeronautical war material as we may justly anticipate it will be in the comparatively near future, and to show how that material may then be used. For that dual purpose the authors have imagined an outbreak of war between several great Powers in the year 1933, and by reasonable developments from existing knowledge and design they have presented conceptions of the vessels of the sea and the air as they may then appear, and have exhibited them in action. Whilst this story is primarily technical, it is not lacking in excitement. We may mention that the *Practical Engineer* was recently acquired by the proprietors of The Engineer, and is published at 33, Norfolk-street, Strand, W.C. 2.

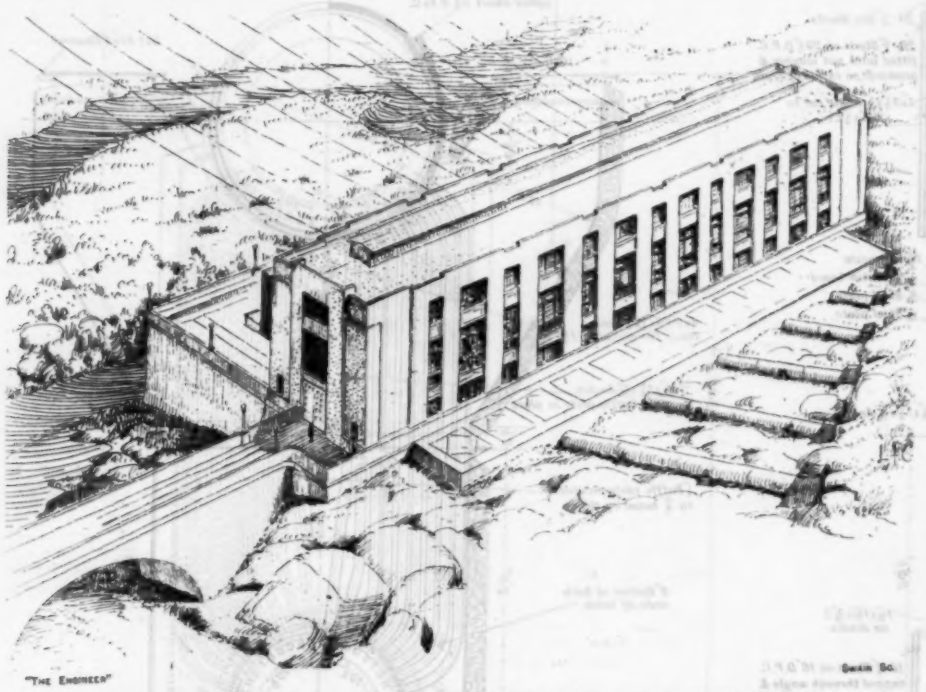
Inquiries have recently been made in Sydney, according to the *Chemical Trades Journal*, by a British-Swedish group on the question of erecting mills for the manufacture of paper from Australian wood pulp. The annual report of the New South Wales Forestry Commission has just been published, and it is noteworthy in this connection that four species of eucalyptus are considered suitable for conversion into pulp, laboratory experiments having shown the resulting paper to be of very good quality.

Large Hydro-electric Power-house in California.

Construction work on the fourth power-house on the Southern California Edison Company's Big Creek-San Joaquin River project, known as the Big Creek Number Three, which will have the largest generating capacity of any hydro-electric power-house in the West of the North American Continent, was started by the Southern California Edison Company on April 12th.

The completion of this power-house will be the consummation of the fourth step in the Southern California Edison Company's Big Creek-San Joaquin project, which contemplates developing one million four hundred and seven thousand horse-power of electricity from the water courses of the High Sierra Mountains in Central California, at a cost of 375,000,000 dollars, say, £75,000,000, or about £3,000,000 more than the Panama Canal. The cost of construction of this power-house is provided for in the annual budget of the Southern California Edison Company, which appropriates 26,000,000 dollars for hydro-electric development and apparatus and transmission and distribution lines during the year 1923.

The initial installation in this power-house will consist of three 35,000 horse-power units, which is one half of its ultimate development. The building will be 200ft. in length, 139ft. in width and 110ft. in height from the tailrace floor to the roof, and will be of reinforced concrete and structural steel. Excavation for the building, which was carried on by means of hydraulic sluices and steam shovels, was started on June 15th, 1922, and the first concrete was poured in the foundations January 10th of this year. The power-house structure will contain the prime movers, but the switching station will be of the outdoor type. The transmission voltage is to be 220,000, which is, we believe, the highest electrical pressure employed up to the present in actual commercial operation, and the extreme distance to which energy will be transmitted is 240 miles. The machinery room of the power-house will be 55ft. in width and 70ft. high, and the building will be equipped with a 125-ton Niles crane, with a 15-ton auxiliary.



PERSPECTIVE VIEW OF PROPOSED HYDRO-ELECTRIC STATION, BIG CREEK, No. 3

The main units will consist of three 35,000 horse-power vertical turbines, built by the Wellman-Seaver-Morgan Company, and equipped with Woodward governors. They will run at a speed of 423 revolutions per minute under an effective head of 760ft. The generators, which will be built by the Westinghouse Company, will each have a capacity of 25,000 kilowatt-volt ampères, 11,000 volt, 50-cycle, and the exciters will be direct coupled. One novel feature of the plant will be that each bearing of the main unit will have its own lubricating oil pump, thus eliminating all outside oil filters, pumps, supply tanks and piping, which are liable to cause more or less trouble in operation. Another novel feature of the design of the power-house is the elimination of the basement in the generator room. As the plant is laid out, the operating floor will be on two levels, one at the base of the generator, and the other at the elevation of the turbine, so that practically all the equipment will be in view of the operator at all times. The switching station will be 195ft. in width by 430ft. in length, and will consist of a series of concrete benches excavated on the slope of a hill, there being a difference in elevation of 46ft. between the upper and lower benches. These benches will support the oil switches, disconnecting switches, frames and insulated piers for carrying the bus-bar structure.

The penstocks for the turbines will be made entirely of lap-welded pipe, varying in diameter from 7ft. 6in. to 6ft., the valves at the bottom of these penstocks being of the needle type and manufactured by the Wellman-Seaver-Morgan Company. At the upper end of the penstocks there will be installed 7ft. 6in. diameter butterfly valves, arranged for control from the power-house. At the upper end of the penstocks there will also be installed a manifold of special design, which will connect the six penstocks of the ultimate installation with an 18ft. steel pipe, connecting to the supply tunnel, which is referred to below. At this point there will also be installed a surge tank excavated from the solid rock. This surge tank will have a shape similar to an hour glass, the largest portion being about 75ft. in diameter. This surge tank will relieve the penstock and tunnel line from risk of damage caused by variations of pressure in the pipe line.

The 21ft. diameter tunnel, which leads from the intake at the diversion dam to the penstocks, is 30,000ft.—nearly 5¾ miles—in length. It has been excavated on a slope of 3ft. per 1000, and has a carrying capacity of 3000 cubic feet per second. The excavation, which is in solid granite, will be unlined throughout, excepting for two or three short stretches where bad ground was encountered. The concrete lining in such places is being put in by pneumatic concrete placing machines, situated in the mouth of the adits to the tunnel. The tunnel is being excavated from the intake and outlet and three intermediate adits, the excavation being done by standard gauge, air-operated shovels, which have been cut down to operate economically in a 21ft. bore. The *débris* is being removed by means of combination trolley and storage battery type locomotives. The drills used for blasting have been especially designed for this type of tunnel. In March, 1922, a world's record for a tunnel of such dimensions was made by one of the crews, 476ft. of progress being achieved during that month. The intake to the tunnel consists of a reinforced concrete structure, 115ft. in height. The flow of the water into the tunnel will be regulated by a 22ft. diameter circular sluice gate, which was designed by the Edison Company's engineering department.

The diversion dam is a simple arch type concrete structure. A 1–2½–5 mixture of concrete was used in its construction, the maximum size of aggregate having to pass through a 4in. mesh. No mass rock or plumb stones were used, but the larger aggregate was put through the concrete mixers with the smaller materials. The maximum height of the dam, from bedrock to crest, is 134ft. Four 7ft. square sluice gates, having a combined discharge capacity of 3000 second-feet, are installed in the dam.

The dam and tunnel intake are situated at the junction of Big Creek and the San Joaquin River, and the power-house is approximately 6 miles down-stream at the junction of Mill Creek and the San Joaquin River. There are already in operation above this plant in the Big Creek catchment area three generating stations carrying the waters from Huntington Lake, at an elevation of 7000ft., to the intake of the Big Creek Number Three plant. There will be an additional plant constructed directly below the Number Three plant, utilising all the available head in the Grand Canyon of the San Joaquin River.

The first 33,000 horse-power generating unit in the Big Creek Number Three power-house will come into operation about August 1st, and will be followed by the second unit about September 1st, and it is expected that the entire plant of the first installation will be completed and the power placed on the lines about October 1st. The building of the superstructure, which was commenced on April 12th, is the final step in two years' preliminary work, which required cutting a road from the face of the precipice above the San Joaquin River, which was one of the most daring pieces of construction work of the period; the boring of 5¾ miles of tunnel; the construction of a new dam across the San Joaquin River; and the hauling of 82,000 tons of material for building the foundations and base of the power-house, which will be of structural steel and concrete, and along the most improved lines of modern construction. This power-house will, it is said, be built in record time, the actual construction work not to consume over 141 days.

On the Big Creek–San Joaquin River development of the Southern California Edison Company, in addition to these five generating stations, there will be some ten stations constructed to utilise the waters coming from the other tributaries of the San Joaquin River, that are not as yet developed. On this development there is a total potential horse-power, which the company proposes to develop within the next ten years, of approximately 1,250,000 horse-power. These plants, when completed, will utilise the waters of the entire drainage area from Mount Hilgard, on the crest, to the San Joaquin River, or a total drop of 2 miles.

Australian Engineering Notes.

The Chief Commissioner of Railways in South Australia, Mr. W. A. Webb, has informed the Railways Standing Committee that, with a view to the purchase of more powerful locomotives, he had made inquiries within the Commonwealth, and in Great Britain, America and Canada, and that as soon as a decision was reached tenders would be called for heavier engines. The Commissioner also intends gradually to eliminate six to ten-ton trucks on the railways, and to substitute trucks with a minimum capacity of 60,000 lb. He also advocates the use in the State of mechanical appliances to facilitate and cheapen track laying.

* * * * * *

The possibilities of hydro-electric power development from the Snowy River, in the south-east of the State, are to be investigated shortly by a party of New South Wales parliamentarians. The generative capacity of the river is estimated at 200,000 horse-power. Complete works to provide this power include a dam and a 20-mile aqueduct, from which pipe lines with a total fall of 1600ft. would carry water to the turbines, and also transmission lines to carry the developed power 80 miles to the point of utilisation.

* * * * * *

The Victorian Government has decided to set aside £100,000 to enable the Electricity Commissioners to extend high-tension mains and low-tension reticulation lines to country centres desirous of using current from Morwell. Applications have been received from sixteen rural municipalities desirous of taking advantage of the power supply, and varying schemes have been prepared to meet their needs, each being based on an existing assured market.

* * * * * *

The City Electric Light Company of Brisbane, is inviting tenders for the supply of one 12,500-kilowatt turbo-alternator unit, for delivery and erection at Bulimba, Brisbane. Tenders will be received up to October 31st.

* * * * * *

The South Australian Harbours Board, Victoria-square, Adelaide, has invited tenders, returnable by July 31st, for the construction and delivery at Port Adelaide, of a floating crane of 60 tons capacity. Alternative tenders will be considered for self-propelling and non-propelling cranes.

* * * * * *

The State Electricity Commission of Victoria, of 22, William-street, Melbourne, requires one electrically-operated power shovel, to excavate brown coal with a specific gravity of 1.2. It is explained that a large dipper can be employed to advantage, and tenderers are requested to quote for a dipper of 9 cubic yards capacity, in addition to stating a price for their own standard sizes. The shovel must be of the large revolving type, designed for control by two operators. The output required is 2000 tons of 2240 lb. per eight-hour shift. An energy supply taken on the machine at 6600 volts is preferred.

* * * * * *

A firm of Australian shipbuilders—Messrs. Morison and Sinclair, of Longnose Point, N.S.W.—has secured an order from the Government of Papua for the construction of a 150 horse-power twin-screw motor vessel, 105ft. in length. The vessel is to be built of Australian timbers.

* * * * * *

The Rockhampton (Queensland) City Council has adopted a resolution to borrow £290,000 for the purpose of carrying out a new water scheme in accordance with proposals outlined by the engineer, Mr. A. J. Gibson.

* * * * * *

Speaking recently at Lithgow, Mr. Cecil Hoskins, of Hoskins' Ironworks, said that the year through which the industry had passed had been a difficult one, and declared that English competition in the iron and steel industry had been felt very severely. He went on, however, to explain that the reason why they were not suffering from it to a greater extent was that the New South Wales Railways Commissioners had seen fit to give them a preference over the imported article.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Buyers Awaiting Lower Prices.

There has been very little business done on the Birmingham iron and steel market so far this quarter, and the calm was more pronounced than ever to-day (Thursday). Manufacturers and merchants stated that buying has practically ceased, and consumers make no secret of the fact that they are waiting for lower prices. There is a conviction in many quarters that the limit of values has been reached, and the tendency for the time being is to watch developments, the more so as people who covered themselves before values reached the top level are in no hurry to negotiate further ahead. There is a sharp divergence of opinion as to what is going to happen. In some circles it is held that the market has already entered on a new phase, which will involve a subsidence of prices. Others argue just as confidently that until there is a fundamental change in the continental situation, present values will be maintained. The reason given for this opinion is that values rest upon the cost of coke, and coke is not likely to be any cheaper as long as producers have the foreign demand at the back of them. Whichever is the correct view, it is apparent that the dissatisfaction with the outlook has encouraged a waiting policy on the part of consumers. There is a good deal of potential business which will not be given out as long as prices remain at their present level. There is no definite break in the market as yet, but the situation is easier in some directions. On 'Change to-day in Birmingham prices, generally speaking, were firm. Billets and sheet bars certainly showed signs of instability and could be obtained at as much as 10s. below last week's figure; but no great significance was attached to this movement, as their position has been even more artificial than that of other commodities. The bulk of opinion appears to favour the view that values have touched their highest point and will now recede.

Billets and Sheet Bars Cheaper.

Values of semi-finished steel have weakened, billets being obtainable this week on rather lower terms, though everything depends upon the circumstances of individual producers. On 'Change to-day quotations ranged from £9 5s. to £9 15s. In exceptional cases as low as £9 2s. 6d. was accepted. A number of steel masters decline to make any concession in their prices, as they are well supplied with orders, and are disposed to await developments. In most cases lower prices are accepted for forward booking. The continental situation appears to have had some influence in producing this lack of confidence in the semi-finished material market. An impression prevails that large consignments of continental steel will shortly be dumped into this country. This view has been encouraged by the report that larger quantities of coke are now being got out of the Ruhr. Belgian exporters are showing themselves anxious to renew their hold upon the British market. Offers by Antwerp shippers are certainly on a somewhat larger scale. There is no sign of giving way as regards values of structural steel. The advances which have been made have discouraged the placing of large contracts, and it is realised that there is a good demand lying dormant which would make itself felt were prices more in keeping with consumers' ideas. Small steel bars are now quoted in some instances at £11 15s., but many firms continue to ask £12. The Belgians are also endeavouring to get into the market with finished steel, but the quoted prices offer little advantage, angles and tees, for example, being offered this week at prices practically the same as those quoted by local steel works. The pressure for steel scrap has eased slightly. This is due in some measure to foreign competition, Germany and Holland having sent in a good deal of this material of late. Buyers of all classes of steel material are exercising great caution.

Manufactured Iron Prices.

Though makers of best bar iron in Staffordshire are fairly well employed, the rollers of lower grade bars are decidedly quiet, and in several instances mills are very partially employed. The improvement in the rolling stock industry has reacted beneficially on the bar mills of this district which make the class of iron used. The last advance of 10s. in marked bars, was made reluctantly, the hands of millowners being forced by the appreciation in raw material and production costs in other directions. These costs continue at the high level and consumers of bars who endeavour to get lower prices are met with a refusal, being told by makers that as long as they have to pay such high prices for pig iron it is impossible that they can reduce quotations, for they are in a worse plight now than at the beginning of the year. For ordinary Staffordshire, ironmakers quote £12 10s. Some attempts have been made to secure enhanced prices, which it is contended should be charged in view of the advances in other districts, but they have not met with much success. South Staffordshire makers of nut and bolt bars are still willing to accept £11 10s. with a level of about £11 12s. 6d., whereas Lancashire competitors ask £11 17s. 6d. and £12 for fencing iron. Belgian shippers are again inquiring for business, and seem willing to take about £9 f.o.b. for No. 3 iron, which works out at about £10 5s. delivered in the Black Country. This is more than £1 below the Staffordshire figure, and it is stated that Darlaston nut and bolt makers are taking this material rather more freely. Delay in deliveries, however, is still a barrier to the placing of large orders. Iron strip is this week quoted £13 5s., but some makers continue to demand £13 10s.

Pig Iron Values Firm.

The pig iron position is practically unchanged. Buyers have been impressed by the reduced coke exports, and have endeavoured to get concessions, but without much success. Sellers of pig iron maintain their prices for current supplies, but in isolated cases they are stated to have quoted somewhat easier terms for future delivery. Foundry iron is very scarce still, and is eagerly sought by founders of all classes. It is, perhaps, not quite so difficult to get odd lots of forge material as has been the case of late. Pig iron smelters are finding a little easement of the coke position, although prices are still strong. The immediate tension is not greatly relaxed, but the outlook is rather more promising. Steps taken to increase the output of coke will gradually become effective, and some ovens, which are temporarily stopped for repairs, will shortly be active again. Coke makers are giving slightly better deliveries, but the supply is still inadequate, and there are numerous complaints of under-production through the insufficient and irregular character of coke supplies. It is in contemplation to restart in the near future several Black Country blast-furnaces which have been idle for a long time. Baldwins Limited have this week relighted a furnace at Netherton. It is turning out forge and foundry iron, primarily for internal use. The capacity of the furnace is about 700 tons a week. Pig iron values this week stand at:—North Staffordshire No. 3 foundry, £5 15s.; Derbyshire forge, £5 to £5 5s.; No. 3 foundry, £5 10s.; Northamptonshire forge, £5; No. 3 foundry, £5 5s. to £5 10s., all at furnaces.

Galvanised Sheets.

Galvanised sheets are maintaining moderate sales at £19 10s. to £19 15s. In this line, however, the prices are considered too high, and there are signs of a falling off in business. The black sheet department is considered the most active in the Staffordshire district.

Improving Conditions in the Birmingham Brass Trade.

The Birmingham brass trade is experiencing a steady improvement both on home and foreign account. At home the expansion is slow, but if the attempt to stimulate house building is reasonably successful, a considerably livelier demand for brass fittings should result. With regard to the export markets manufacturers report that buyers from whom they have received no business for eighteen months past are reopening negotiations. Underselling by Germany, though far from being a negligible quantity, is much less in evidence, and business with the Continent is gradually assuming a wider range. India is sending better orders for stamped wares, particularly cabinet furniture and various household goods. A few inquiries are coming in from China, and trade with Australia and New Zealand is showing a fair amount of activity. South America is again calling for plumbing goods, of which it took considerable consignments in pre-war days.

Brierley Hill Pit Disaster.

A serious mining accident happened with tragic suddenness on Saturday last at what is known as "The Dandy" Pit, Pensnett, two miles from Brierley Hill, and at the time of writing it is feared it will result in the loss of four lives. The pit is worked by Messrs. H. S. Pitt and Co., who are owners of other industrial enterprises in South Staffordshire. The disaster was due to a sudden inrush of water. When the accident happened there were fifty-three men at work underground, but fortunately all except five managed to make their escape. One has since been rescued after being imprisoned for something like forty hours in the flooded mine. The general theory as to the cause of the accident is that it arose through the collapse of a barrier of a water-logged working. This is the most serious disaster that has occurred in the Brierley Hill coalfield since the "Nine Locks" accident over half a century ago, when a number of miners were entombed.

Colliery Fire at Nuneaton.

The Newdigate Colliery, near Nuneaton, was, on Saturday last, the scene of a surface outbreak of fire, which resulted in damage to the winding plant of the down-cast shaft, a number of mine buildings and a large quantity of coal, extending to several thousands of pounds. Forty men were underground at the time, but they reached the surface in safety. As the result of the fire some 1500 have been temporarily thrown out of work.

Unemployment Decreasing.

The latest unemployment returns for the West Midlands are again very satisfactory, showing, as they do, a substantial reduction in the number of persons out of work in this area compared with the previous week. The returns for the week ended April 16th show the total number of persons registered as unemployed to be 130,700, as compared with 133,625 for the previous week, a decrease of 2925. In the Birmingham area the decrease was 315. The number of workless in the various Black Country towns now stand at Birmingham area, 42,790; Cradley Heath, 4680; Darlaston, 2017; Dudley, 4652; Smethwick, 6265; Walsall, 6161; West Bromwich, 3581, and Wolverhampton, 8514.

LANCASHIRE.

(From our own Correspondents.)

Manchester, Thursday.

General Outlook.

The general condition of the iron and metal markets is quieter than it was, and the opinion that prices, at any rate, in iron and steel, have seen the top and are likely to come down, is stronger than it was last week. There is less being done on the Manchester market, and this may perhaps assist the belief that a change to easier prices is near at hand; or, at any rate, that no further advances will take place. That costs of making iron and steel can be reduced very much in the near future does not seem probable now that the railway authorities have decided not to make any concession in the carriage on iron and on iron-making materials. The only other thing which will reduce costs is much cheaper and abundant fuel, and that cannot come until the continental demand falls off. Hence one does not see any probability of a rapid decline in prices, but they may sag a little if consumers persist in keeping off the market.

Metals.

In the non-ferrous metal market there has been some ease lately, although it has been less apparent in copper than in other metals. The actual amount of the fall in standard copper since the middle of March is only £2 per ton; but this is, of course, a disappointing movement, because in March many people were indulging in the hope that the spring would bring about a much better market. Consumption here, however, does not improve with the spring, and seems rather to be declining. Certainly metal merchants in this district complain that they are not doing so much as they were; and this is particularly the case with regard to scrap metals. The continental demand for copper has been poor, but it is said that the American domestic demand keeps up very well. The fact is that it has been the American industrial demand which has sustained the market, for even last month, when the consumption here was better, there was nothing very satisfactory about it. There has been no change in the prices for manufactured copper and brass. These are still maintained at comparatively high rates, and consumers naturally grumble; but they are helpless in the absence of competition amongst the manufacturers. A good deal of uncertainty prevails in the market on tin. There seems to be some apprehension that the liberation of Eastern stocks at the rate of 880 tons per month will prove too much for the market; but we understand that if this be the case, less tin will be sold by the F.M.S. Government. Probably the late weakness of the market was the result of the falling off of the American demand, for there is no doubt that tin prices are now far more dependent upon American business than they used to be. The idea in this district is that tin will probably go back to £200 per ton before consumers begin to show a fresh interest in it; but, of course, this is merely guesswork. The market for lead has been dull, and business is restricted. The dulness is usually attributed to the dispute in the building trade; but one has some doubt whether this is the real or the only cause. The probability is the lead prices are too high, and that people are beginning to realise that the chance of a fall is greater than the chance of a rise; and consequently they do not buy very freely. Spelter has also been a very weak market of late. Consumers have been holding off, buying only small quantities when they must. On the other hand, the supplies of metal are only very moderate, and neither Germany nor Belgium is offering very much.

Pig Iron.

The markets for pig iron are very quiet here; makers have plenty of orders in hand and are not pressing sales; and, on the other hand, consumers are not inclined to buy at the present prices. The market for foundry iron is still based on 110s. per ton at the furnaces, and as there is to be no immediate reduction in the rates of carriage, the prices in Manchester remain at 118s. 3d. to 120s. Merchants would no doubt sell freely for forward delivery at these prices, and perhaps at a little less; for many of them, if not all, are fairly well convinced that we are now at the top of the market; but consumers here hold the same view—perhaps more strongly than the merchants—and the probability is that most of the business done during the next two or three months will be of a hand-to-mouth character. Many of the Manchester consumers must now be getting bare of stock, but they will not buy freely until they are better assured of the market. It is reported that the Cleveland export demand is falling off; and this will mean that the alternative market in the North for Derbyshire iron will not exist much longer. In that case Derbyshire furnaces will again be more largely dependent upon Lancashire consumption, and this is an additional reason in support of the consumer's theory that foundry iron will not be so dear in the third quarter of the year as it was during the second quarter. At any rate, very little new business is now being done here in the foundry iron market. Scotch iron remains at 140s. per ton delivered. East Coast hematite costs a little less.

Steel.

The nominal prices here for finished steel are much as they were, viz., £10 12s. 6d. to £10 15s. for joists and angles; £11 5s. to £11 10s. for flat bars and common plates; and £12 10s. for round bars; but there are reports that the export demand for steel is failing; and if this be the case, buyers here are probably wise to wait and see what effect this will have later on upon the home prices.

Scrap.

The markets for scrap are very dull and quiet, but the dulness is most pronounced in cast scrap. Dealers here are trying to maintain the price of 95s. per ton for ordinary broken machinery cast scrap, but they do not find much business; and there are reports of lower prices. Ironfounders are not buying very much at the moment, and the low prices do not seem to tempt them. Both wrought scrap and steel scrap seem to be easier, but they are not so depressed as cast scrap.

The Engineering Trades.

Although it is still impossible to report any really substantial all-round improvement in the local engineering trades, several exceptions to this statement have come to my knowledge during the past few days. Two of the most important firms in their own particular branch of engineering have furnished me with very satisfactory reports with regard to their order books. These are all the more gratifying inasmuch as the orders are chiefly from abroad. One of the most important is a contract obtained by West's Gas Improvement Company, Limited, for forty large vertical gas retorts for America. This is a feather in the cap of the British gas engineers, and it is hoped that the example will shortly be copied by other Transatlantic buyers of gas plant. Although

not yet hard up for work, I understand that the outlook in the textile machinery industry leaves room for improvement. Many more orders are required if the shops are to be kept going at their full capacity. The news given out a few days ago that Crosses and Winkworths are about to build a new mill in Lancashire, with 116,000 spindles, has been received with joy at Oldham, but many more new mills will have to be built to satisfy all the makers of spinning machinery. Much regret is felt locally that the old-established motor car manufacturers, Belsize Motors, Limited, has fallen on bad times. Two winding-up petitions have been presented, but it is to be hoped that compulsory liquidation will not have to be resorted to. The works of this company were greatly enlarged during the war, and the plant and equipment are of the most efficient types. The Belsize Company has taken a prominent place in the motor car industry since the earliest days of the movement, and has found employment for a very large number of hands in the Openshaw district.

BARROW-IN-FURNESS, Thursday.

Hematite.

The hematite pig iron trade continues to be lively, and there is no evidence of it easing in any branch. There is just a hope of a better coke supply, and this is creating more confidence. Another furnace has been put into blast at Workington. As to whether the better supply of coke will tempt makers to increase the number of furnaces is a difficult thing to say. All smelters are inclined to be cautious, for should the Rhur trouble be overcome, there is every likelihood of trade becoming normal again. During the past week there have been shipments from Barrow of a quantity of pig iron for South Wales, Glasgow, Antwerp, and two cargoes for Boston.

Iron Ore.

There is no change in the iron ore trade, which is fairly well engaged, but, of course, if the number of furnaces were increased it would improve considerably. The Cumberland mines are the busiest and likely to be. Not a large quantity is being sold out of the district. The foreign ore is being imported in moderate quantities, and another cargo has arrived at Barrow from Kirkenes.

Steel.

Generally speaking, the steel trade is only fair. The rail mills at Workington have stopped, but the Siemens are still kept on. The rail mills at Barrow are still employed, and there is no sign of them stopping at present. The hoop and small bar mills are well employed and are pretty well booked with orders. Foundries are experiencing better trade, and one firm has an order for railway chairs for a British company.

Shipbuilding and Engineering.

The shipbuilding trade is improving and more men are being taken on, but workmen in other parts of the country are warned that it is not wise to make for the Barrow district, as there are quite sufficient men in the neighbourhood at present unemployed waiting to be sent for by the firms. The dispute which overshadows the trade is expected to be settled. That is the opinion in this district anyhow. There are no new orders to be reported, but more optimism is felt about the future, and there may be some satisfactory news to communicate at a later date.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

THE open-hearth furnaces in Sheffield and district are still working away merrily, turning out great tonnages of mild steel, but at the moment they cannot see a great deal of employment ahead of them. Customers who had been following a hand-to-mouth policy of buying for a long time had just got into the way of ordering on a substantial scale again when prices made several jumps in quick succession, and the placing of new business has suffered a check in consequence. Prices now show a tendency to ease off a little. There is still an urgent demand for all the pig iron that can be produced, and more blast-furnaces are going into commission. The Stanton Ironworks Company, near Ilkeston, has just relighted four furnaces that had been idle for a couple of years. The kindling of the fourth of the series was performed by Mr. J. R. Clynes, and was made the occasion of an interesting ceremony, which was attended by Labour leaders and prominent citizens of the district.

Railway and other Work.

A falling off of business is reported by makers of most kinds of heavy steel, whether rolled or forged, although there are still instances of much activity. The departments concerned with the manufacture of railway steel are among the busiest in the city, although they are not altogether fully employed. Orders for axles, tyres, springs and buffers are on hand in large number, and new ones continue to come in. While there is a good demand for castings for colliery equipment, the heavy forges and foundries generally are far from well off for work. At one or two of the mills full time is being run, but the rest can only make three or four days a week. The motor trade is providing a moderate amount of work. There is nothing new to say about the crucible steel and high-speed steel branches, which, although brightened up by an oasis of activity here and there, are in the main very dull.

Death of Sir Albert Hobson.

Universal regret is felt throughout commercial circles, not only in Sheffield, but in the country at large, at the death of Sir Albert Hobson, which occurred last Friday. Sir Albert was a commercial and financial magnate of outstanding ability, as well as a great local citizen. He was intimately connected with the steel trade as chairman of William Jessop and Sons, director of the Birmingham Small Arms Company after that concern had absorbed Jessop's, vice-chairman of High-speed Steel Alloys, Ltd., and in many other capacities, and was also one of the leading cutlery manufacturers of Sheffield. He served his native city in several of the most important positions which she had to offer—as Lord Mayor, Master Cutler, President of the Chamber of Commerce and Vice-chancellor of the University. His eminence in national commercial circles was shown by his election, only two or three years ago, as President of the Associated Chambers of Commerce, and he was also one of the most prominent members of the International Chambers of Commerce. His death, at the comparatively early age of sixty-one, may, in some measure, be attributed to his labours for the latter body, for, although far from well, he went to the recent Conference at Rome, came home suffering from the fatigues of the meetings and the journey, and was attacked by his fatal illness immediately after.

Hull's Tram Rail Contract.

Sheffield people will not be inclined to waste much sympathy with Hull Corporation on the position in which that body unexpectedly finds itself with regard to assistance from the Unemployment Grants Committee. I have referred several times to the fact that Hull refused a Sheffield tender—the lowest received from this country—for the supply of 2000 tons of rails, and gave the order to Belgium, at a saving of £10,000. Not only that, but the Corporation has recently given a repeat order to the same Belgian firm. Now, it has applied to the Unemployment Grants Committee for a grant in respect of the renewal of tramway track, and has been told in reply that the grant cannot be given if the materials are purchased abroad. "It was recently laid down as a condition," says the Committee, "that local authorities should be required to place within this country all contracts in relation to relief when assisted by Government grants." Hull's saving of £10,000 is, therefore, more than counterbalanced by the loss of an anticipated grant of £15,000, but the Hull people are consoling themselves with the reflection that they will save the other £5000 on labour, as the contractor will now be enabled to engage labour direct instead of through the Employment Exchange. They are also complaining that they were not aware of the ruling of the Unemployment Grants Committee when they placed the contract, and are proposing to invoke the assistance of their local members of Parliament in the matter.

A Lincoln Firm.

The directors of Clayton and Shuttleworth, Limited, have sent out, along with their report for the past year, a special report by their auditors. The latter point out that, owing to the crippled state of Eastern Europe since the war, and to changes in farming methods in South America, the company's standard trade of manufacturing agricultural machinery "has, in effect, ceased to function." In this predicament, the directors have had to establish new lines of manufacture, and have decided upon railway carriages and wagons and water-tube boilers. Considerable progress has been made in these directions, and both directors and auditors consider that, with a general improvement in trade, it will be possible to re-establish the company's business on a satisfactory basis. For the past year, the company made a loss of £12,469.

Cutlery and Plate.

There is no improvement in the state of these old trades. The leading houses are quiet, and the large orders which are about for stainless cutlery, as well as plate for the equipment of hotels and seaside boarding-houses, are, to a considerable extent, going to small firms which are prepared to quote low prices. There is a fair demand from the Colonies, but the general trade in the home market is on a limited scale, and shopkeepers state that sales over the counter have fallen below the level of recent years. Although imports from Germany are declining, while prices continue to rise, competition from this source is still felt.

Clinker Asphalt Roads.

Some very interesting evidence as to the value of clinker asphalt for roads subjected to very heavy traffic was placed before members of the Institution of Municipal and County Engineers who visited Sheffield last Saturday. The Corporation has its own depôt for making clinker asphalt—which, of course, uses up a waste product—and this material has been laid down in some of the most hardly used streets in the industrial part of the city. Mr. W. J. Hadfield, the city surveyor, called the visitors' special attention to Newhall-road, which lies between the foundry where heavy castings, such as ingot moulds, are made, and the works where they are used. Weights up to 70 tons (on four wheels) frequently pass over it. Originally the surface was water-bound macadam, then tar-macadam was substituted, but neither would stand the traffic. Then, in September, 1917, clinker asphalt was put down, and none of the heavy weights referred to have made the least impression on it. The same material has served excellently in Brightside lane, the principal East-end artery, which passes between most of the large steel works and carries very heavy traffic of almost every kind. Opposite Messrs. Vickers' works the whole width of the road, including tramways, has been surfaced with asphalt since August, 1920, and there is no grooving alongside the rails. Clinker asphalt to-day costs less than 7s. per yard, and can be paid for out of the year's rate instead of necessitating a loan which would eventually add 50 per cent. to the heavy initial cost of paving; it is silent, sanitary and easily cleansed; and it does not subject pedestrians to that splashing of mud which is inevitable when a rubber-tired lorry passes over sett pavement, even in moderate conditions, on a wet day.

New Bridge Proposals.

An important scheme of bridge construction is proposed at Rotherham, where plans have been prepared for the building of a new main road crossing over the river Rother, just before the stream joins the Don. The present Bow Bridge, which is to be reconstructed, forms a dangerous "bottle neck" at the entrance to the town on the Sheffield side. The new structure will be 70ft. wide between parapets, will be built of concrete, and is estimated to cost £25,000. There is no other roadway over the river, so that it will be necessary to carry out the construction in such a way as will not cause serious stoppage of traffic. This will increase the cost, as the tramway track will have to be taken up and relaid three times. The Road Board is to be asked for a grant, and in the event of this being obtained the Corporation proposes to push on with the work of construction this summer. At Thorne there is to be a reconstruction of Toll Bar Bridge and New Bridge to carry modern traffic. This has been definitely decided upon as the result of the Ministry of Transport's Conference on the present "hold up" of heavy traffic over the bridges, and all that remains to be agreed is the sum which the Sheffield and South Yorkshire Navigation shall contribute towards the maintenance of the new structures.

New Coke Ovens.

A reconstruction of coke oven plant is in progress at Wharncliffe Silkstone Colliery, near Barnsley. The old waste-heat battery has been dismantled, and an up-to-date battery of regenerative ovens of the most approved type is being built on the site. It is expected that the new plant will be in full work before the end of this year.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Break in Pig Iron Prices.

THE outstanding feature in pig iron trade circles in the North of England this week has been a reduction of 2s. 6d. per ton in prices, and in view of the present strong position of the industry the decline has occasioned a good deal of surprise. It is the first break in pig iron prices which has occurred since the boom commenced at the beginning of the year. The demand for pig iron just now is certainly extremely quiet, both for home consumption and for export, but makers are well sold ahead, some of them having disposed of the bulk of their output for the next three months. Thus, apart from the temporary slackening in the demand, there has been nothing to warrant a decline in prices. Coke is as scarce and dear, and costs of production as high as ever they were. Only temporary conditions seem to have influenced the decline in prices, and it is by no means certain that any definite break is at hand. No 1. Cleveland foundry iron is now 130s.; No. 3 G.M.B., 125s.; No. 4 foundry, 122s. 6d.; and No. 4 forge, 117s. 6d., although the latter quality is very scarce indeed, and might realise more.

Hematite Pig Iron.

The position in the East Coast hematite trade is also a little easier. Producers have shown a keener interest in the market lately, and are now disposed to cut prices for suitable business. Some still adhere to 125s. for mixed numbers, but a substantial order can now be placed at 122s. 6d. per ton.

Iron-making Materials.

The foreign ore trade is practically lifeless. Prices have been cut to a minimum without attracting business, and sellers are now content to wait until the gradual exhaustion of stocks brings buyers on the market again. Of that there is no immediate indication, imports this month under running contracts being very heavy, but sellers adhere to their quotation of 24s. 6d. per ton c.i.f. Tees for best Rubio ore. Blast-furnace coke is still no cheaper to the ironmaster. The export demand is not so strong, but there are still plenty of avenues for the disposal of coke abroad at prices far above the home quotations, and sales of Durham furnace coke to the local ironmasters at 43s. per ton still represent a substantial sacrifice on the part of the seller.

Manufactured Iron and Steel.

The manufactured iron and steel trade has assumed a quieter appearance, but the works are not badly placed for orders, and there is no indication of any weakening in prices. After the recent lull there is again a livelier inquiry for galvanised corrugated sheets, and producers are sold for months ahead. Cheap Belgian billets are now being offered in this district, but business is retarded by uncertainty about the date of delivery, buyers not being disposed to place orders without some guarantee.

New Coal-loading Plant for the Tees.

An important development is to be made in the coal-loading facilities on the river Tees. Bell Brothers, Limited, have placed an order with the Thornaby firm of Head, Wrightson and Co., Limited, for the erection of a new plant for loading coal cargoes, the intention being to provide on the north side of the river, close to the Clarence Ironworks, an up-to-date plant for the rapid handling of coal in bulk.

The Coal Trade.

There is no apparent alteration in the position of the Northern coal trade, which maintains all its recent rigidity, and is as unyielding as ever. The pressure for supplies seems to grow daily, and, as the turns are fully arranged, there are few, if any, opportunities of booking new business for any comparatively early loadings. The collieries in both Northumberland and Durham report themselves practically besieged with inquiries for spot supplies, but as they are unable to take more tonnage this month, nothing much can be attempted, except to facilitate

the discharge of existing contracts. At the present time, the question of loading turns is very difficult to solve. Strings of steamers are undergoing serious detention, and consequent heavy demurrage charges, at every dock and staith on the Tyne, Blyth or Wear. The forward outlook appears to be gradually improving. There are not many actual transactions for July to December shipments, while for further ahead the number of deals is smaller still. There are, however, any number of feelers and soundings of the market with a view to keeping in touch with the position from day to day. This augurs well for the rest of the year, and should eventually result in considerable commitments being completed, though there is a decided disposition to hold off as long as possible in view of probable reductions in value which many people still look for. There is nothing in the way of heavy pressure from Germany at the moment, but that country is expected to come on the market again in the near future for large quantities for third-quarter supplies. Northumberland steam coals are firm at top prices direct from the collieries, and in second hands there are only few opportunities to discount prices, bests and smalls of all brands being very scarce for any reasonably early date of shipment. Durham gas coals are well off for trade for a while onward, and most of the fitters take an optimistic view of the situation, both for prompt and forward. Coking coals are the firmest feature, and can only be secured occasionally at full figures, which cannot be modified in any instance. Bunker coals are scarce and strong for every class. The coke market is slightly easier for all sorts of furnace and foundry kinds, but the break in values is not expected to last very long. Gas coke is quiet and easier.

Coal Miners' Wages Increased.

The report of the accountants on the state of the coal-mining industry in Northumberland in January and February, which regulates wages in May and June, shows that the percentage on basis wages will be 105.15 per cent., as compared with 95.30 per cent. in March and April, an increase of 9.85. This will mean an increase of about 6d. per shift to higher-paid men and about 3¼d. per shift to lower-paid men.

Cleveland Miners' Wages.

The Executive of the Cleveland Ironstone Miners' Association has given consideration to a scale of base rates which is being devised with the object of standardising wages for the various grades of labour in and about the mines and also an improved sliding scale. These matters will come before a joint meeting of the owners and men's representatives at an early date, the owners having promised sympathetic consideration in view of the men accepting the eight-hour-day proposal.

New Works Developments.

A new battery of eighty coke ovens has been completed at the Port Clarence Works of Dorman, Long and Co., Limited, Middlesbrough. A blast-furnace has been dismantled at the Newport Ironworks belonging to the same firm, and a second furnace is being demolished. They are to be replaced by modern furnaces.

SCOTLAND.

(From our own Correspondent.)

Diminishing Activities.

THE past week has witnessed a further step towards curtailed buying in steel and iron markets generally. The appreciation of production costs and the accompanying increase in prices has resulted in a hesitancy on the part of consumers to lay in stocks of material, and the tendency now is to return to the "buy only for absolute requirements" principle. Efforts to reduce prices are not meeting with much success, and in this connection great disappointment is felt at the non-inclusion of steel, iron and coal in the railway transport charges. These industries have long been advocating considerable reductions in carriage charges, and though some little concessions have already been granted these have been too small to have a real beneficial effect on trade. The concessions referred to resulted in increased traffic and also greater revenue to the railways, and it was hoped that the movement might be extended to bring charges nearer to pre-war levels. Everything has been done in the way of reducing production costs at the works, but the transport of all materials required, both singly and collectively, means a large addition to prices. Transport charges, dearer home raw materials, compared with formerly imported stuffs, have created higher prices, while wages have been reduced to practically the lowest possible standard, and even then unemployment is still very prominent. The continental situation is, of course, responsible to some extent for present local conditions, but cheaper rail charges would be of great benefit to the producer eager to secure work at a modest profit. Scotch producers contracting for work outside their own borders have heavy calculations to meet in the way of transport charges, which often mean the loss of a good contract, and such has repeatedly been the case within the last month or two and even before prices attained to their present level. Apart from the above-mentioned considerations, however, an unsteady feeling is permeating markets. Possible changes abroad and labour difficulties at home are causing buyers to hold back until a more definite state of affairs is established.

Quiet Demand for Steel and Iron.

The steel and ironworks in operation have a number of orders to execute, which will mean employment for at least a month or two ahead, but beyond that the outlook is unsatisfactory. Steel makers are doing a little in sectional material and sheets, the latter chiefly on export account, but new business is small in bulk. Even at present levels makers do not consider that prices are very remunerative, but have decided against a further increase meantime. Bar ironworks are in a fairly comfortable position at present, and steel makers report good local inquiries. Re-rolled steel bars also have a good market. Pig iron has fallen off. Supplies are increasing and quotations are easing, but prices are now more a matter of negotiation. Wrought iron and heavy smelting materials are difficult to obtain even when full prices would willingly be paid.

Shipyard Lock-out Notices

Although lock-out notices have already been posted in the federated shipyards, it is confidently expected that something will yet be done to obviate the lock-out. It is stated that between 10,000 and 15,000 employees on the Clyde would be affected.

Coal.

The collieries are still busy with orders placed during the boom period, therefore little change has taken place during the week. Apart from instances where holders have been anxious to get rid of old purchases, there has been really nothing of any consequence for prompt disposal. The second-hand lots referred to have sold below colliery rates, but prices generally have been practically unaffected. The congestion at the East of Scotland loading ports is decreasing, but the delays are still very serious to exporters, who are being faced with heavy demurrage charges. The bulk of the exports have gone in foreign directions, chiefly to Germany, France, Belgium and West Italy. Aggregate clearances amounted to 386,252 tons—226,948 foreign and 79,652 coastwise—against 394,631 in the preceding week and 243,720 tons in the same week last year. Local industrial orders have suffered further reduction owing to increased charges.

Developments at Shotts.

Two new coal pits were mapped off last year by the Shotts Iron Company, and machinery is being erected to produce 1200 tons per day. It is said that the company intends to strike into the basin of the Hawthornden area, boring to a depth of shaft approaching 340 fathoms. It is estimated that a modern colliery worked at such a depth would involve an outlay of at least £500,000. Recently this company acquired the collieries of the Baton Company in the Shotts area. The daily output from the Shotts company's pits is 6400 tons.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE congestion prevailing at practically all South Wales ports is still very acute, and it is very difficult to arrange fresh cargoes for anything like early loading, yet the tone of the steam coal market is easier for shipment next month. Based on the sales which collieries have made, their position is good, but the trouble is that the middlemen who hold a considerable amount of coals on contract and which they have to find a market for abroad, do not find it at all an easy matter to get the foreigner to purchase at prices represented by the current market values, plus the cost of freight, &c. Germany has not been doing much in the buying line for several weeks past, though it is possible that they may be in the market before very long for further supplies. Should this be the case, it will have the effect of checking the weaker tendency at present in evidence, and, further, the fact has to be taken into consideration that during the second half of May production of coals will be interfered with by the Whitsuntide holidays. At the moment, however, continental consumers are showing no eagerness to purchase, and in the case of Italy, consumers have been able to buy Welsh coals cheaper than they can be shipped, the reason being that importers had contracted for supplies, and when the cargoes arrived out at Italian ports the demand was so meagre that they had to sell the coals at reduced prices in order to find an outlet. The inquiry for coals from Belgium is fairly good, but in the case of France it is comparatively quiet, and the feeling prevails that current prices must come down to an appreciable extent to arrive at a really workable level. A certain amount of coal, principally anthracite and semi-anthracitic, is being shipped to Canada, but the quantity as yet is not what can be described as considerable.

Three-shift Question.

So far, nothing definite has been arrived at regarding the question of a third shift for trimmers and tippers at South Wales ports. The Court of Inquiry appointed by the Ministry of Labour was due to resume its sittings at Cardiff on Thursday in last week, but the inquiry was adjourned to enable negotiations between the representatives of the employers and the workmen to be carried on in order, if possible, that a satisfactory agreement might be come to. As a matter of fact, representatives of the parties met at Cardiff on Monday, but the employers were unable to make any concessions upon their previous offer. After the representatives of the men had considered the subject in private, they came to the decision to refer the terms to a conference of the men to be held on Monday next, after which the representatives of the men will again meet the employers.

Non-unionism in the Coalfield.

After a stoppage lasting about eleven weeks, the men at the Nine-mile Point Colliery are back at work, much to the relief of this district. The position is that the dispute between the mechanical workers and the South Wales Miners' Federation is to be thrashed out in London before the General Council of the Trade Union Congress. Work was actually resumed at the colliery on Monday last, but it will be some time before all the miners will be able to work, owing to the condition of the workings. A resumption of work was brought about by the resolution of the mechanical workers to pay the Federation fees under protest. The men will, as a matter of fact, pay contributions to both unions for the time being. The mechanical workers are hopeful that by having the question at issue discussed by representatives of trade unions who enjoy independent positions, their final decision will be that the mechanical workers shall be allowed to continue their trade union without interference from other trade unions in the coalfield. The Council of the South Wales Miners' Federation at a meeting on Monday last received an application from the National Federation of Enginemen and Boilermen, to which the Mechanical Workers' Union is affiliated, suggesting that they should receive a deputation to discuss the question of the organisation of the mechanical workers; but the Council decided to allow the letter to lie on the table, as, in their view, there was nothing to discuss. In conformity with a decision previously reached, the miners in the Pontypridd district were to have tendered notices on Monday night on the non-unionist question, but so far as can be ascertained, only about 1500 out of 7500 men have actually served notices upon the collieries at which they are engaged. The men's leaders intend, however, during the next fourteen days to carry on an intensive show-card movement, and if this is not successful in getting the non-members back to the fold, the whole of the collieries in this district will be stopped working at the expiration of the notices.

Tin-plate Conciliation Board.

The question of formulating claims to be considered at the annual meeting of the Conciliation Board to be held shortly has already been before the various sections of the men employed in the tin-plate trade, and the probabilities are that this year the subjects to come before the Conciliation Board will be more important than has been the case for some time—if, indeed, not more difficult to settle. It is reported that a point of disagreement has arisen between two of the unions themselves, this being to the effect that the millmen who, under an agreement between the Transport Workers' Union (Dockers) and the Iron and Steel Confederation, were to be taken over by the latter union, but the millmen have declined to go over to the Union in question.

Swansea's Oil Trade.

The report is current that important developments are contemplated at Swansea for the extension of the Anglo-Persian Oil Company's bunkering facilities at the Queen's Dock, as a consequence of which regular visits of large liners are expected for the purpose of bunkering with oil fuel. It is understood that one plan under consideration is the provision of facilities for oil-bunkering warships in Swansea Bay, thus rendering it unnecessary for the vessels to enter dock.

Rumoured Steel Combine.

During the past week the ordinary shares of Guest, Keen and Nettlefold, Limited, and Baldwins, Limited, have risen rather sharply upon rumours of probable combination, which, if true, would involve a twenty-million-pound scheme. The reports concerning the amalgamation are not confirmed, but there is reason to believe that they are quite incorrect.

Current Business.

The tone of the steam coal market is easier. The inquiry from abroad is comparatively quiet for May shipment, and whereas last week leading collieries were quoting up to 42s. 6d. for best Admiralty large, the price is now nearer 38s. 6d. to 40s., with second qualities round about 37s. 6d. Small coals, however, are still very scarce and firm at 30s. to 32s. 6d. for the superior grades. House coals have been advanced from 30s. to 35s. at the pit. Authracite coals are very steady, especially sized coals and duff.

Swansea Metal Trade.

The tin-plate market shows very little change, but operations are on the quiet side and prices display an easy tendency.

CONTRACTS.

AMONG the orders recently received by the Underfeed Stoker Company, Limited, are those for forty-five travelling grate stokers from ten separate customers, Barking electricity station alone taking ten; for twenty-two Underfeed stokers from four separate customers; for an ash conveyor and for furnace arches from six separate customers.

FOIRE DE PARIS.—The fifteenth National Sample Fair will be held in Paris from May 10th to 25th. Detailed information can be obtained on application to the French Commercial Office, 153, Queen Victoria-street, London, E.C. 4.

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society will be held at Coombe Hill, Kingston Hill, Surrey, on Wednesday, May 9th, by the courtesy of the Golf Club. The following is the programme for the day:—Morning: The President's Challenge Cup, presented by Sir Alexander Kennedy, for members in the First Division, with handicaps of 10 and under, 18 holes stroke competition under handicap; and the Wilson Challenge Cup, presented by Mr. R. P. Wilson, for members in the Second Division, with handicaps of 11 and over, 18 holes stroke competition under handicap. A memento and a second prize will be given in each division. There will also be a prize for the best scratch score, presented by the Captain, Mr. S. R. Lowcock. Afternoon: Four-ball foursomes match play against bogey, 18-hole round. Stroke allowance three-quarters of handicap, fractions of one-half and over to count as one stroke. There will be two first and two second prizes for this competition. The entries close first post on Thursday, May 3rd. The Society also proposes to hold during the current season a match play tournament under handicap on lines similar to those of 1922 and open to all members of the Society. Entries close on Thursday, May 3rd. Further particulars of the spring meeting and of the tournament may be obtained on application to the hon. secretary, Mr. Walter L. Mansergh, 5, Victoria-street, Westminster, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W Coast—	
Native	26/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) **Scotland—**		
Hematite	6 7 6	—
No. 1 Foundry	6 2 6	—
No. 3 Foundry	5 17 6	—
N.E. Coast—		
Hematite Mixed Nos.	6 5 0	6 5 0
No. 1	6 6 0	6 6 0
Cleveland—		
No. 1	6 10 0	6 10 0
Silicious Iron	6 10 0	6 10 0
No. 3 G.M.B.	6 5 0	6 5 0
No. 4 Foundry	6 2 6	6 2 6
No. 4 Forge	5 17 6	5 17 6
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge *	—	—
" " Foundry	5 12 6 to 5 15 0	
(3) Northampton—		
Foundry No. 3	5 8 0 to 5 10 0	
" Forge	5 0 0	—
(3) Derbyshire—		
No. 3 Foundry	5 7 6 to 5 10 0	—
Forge	5 0 0 to 5 5 0	
(3) Lincolnshire—		
Basic (none offering)	6 0 0 to 6 10 0	
Foundry	5 10 0	—
Forge	5 5 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	7 0 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best "	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 15 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best "	13 10 0	—
Hoops	15 10 0	—
Midlands—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 10 0 to 11 12 6	
Gas Tube Strip	13 5 0 to 13 10 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) **Scotland—**		
Boiler Plates	13 0 0	—
Ship Plates ¼in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	20 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 0 0	—
Joists	10 0	—
Heavy Rails	10 10 0	—
Fish-plates	14 10 0	—
Channels	9 5 0	—
Hard Billets	10 15 0	—
Soft Billets	10 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	10 0 0	—
Light "	12 10 0	—
Billets	11 0 0	—
Manchester—		
Bars (Round)	12 0 0	—
" (others)	11 0 0 to 11 5 0	
Hoops (Best)	15 5 0	15 0 0
" (Soft Steel)	13 15 0	13 10 0
Plates	11 0 0 to 11 10 0	
" (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	13 10 0	—
Hard Basic	10 15 0	—
Intermediate Basic	10 10 0	—
Soft Basic	9 10 0 to 10 0 0	
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	13 0 0 to 13 10 0	
Midlands—		
Small Rolled Bars	11 15 0 to 12 0 0	
Billets and Sheet-bars	9 5 0 to 9 15 0	
Gas Tube Strip	12 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	19 10 0 to 19 15 0	
Angles	10 10 0	—
Joists	10 10 0	—
Tees	11 10 0	—
Bridge and Tank Plates	10 15 0 to 11 0 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	21 3 to 25/-
Block Tin (cash)	215 15 0
" (three months)	215 15 0
Copper (cash)	72 5 0
" (three months)	73 0 0
Spanish Lead (cash)	26 5 0
" (three months)	26 10 0
Spelter (cash)	33 12 6
" (three months)	33 15 0
Manchester—	
Copper, Best Selected Ingots	77 0 0
" Electrolytic	80 10 0
" Strong Sheets	106 0 0
" Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 1
" Condenser	0 1 2½
Lead, English	27 10 0
" Foreign	26 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
" 6 p.c. to 8 p.c. "	£21 0 0	8/-
" 8 p.c. to 10 p.c. "	£20 0 0	8/-
" Specially Refined		
" Max. 2 p.c. carbon	£52 0 0	20/-
" " 1 p.c. "	£62 0 0	22/6
" " 0·75 p.c. carbon	£72 0 0	25/-
" carbon free	1/6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£16 for home.	
" Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
" " 75 p.c.	£21 0 0 scale 6/- per unit	
" Vanadium	17/- per lb.	
" Molybdenum	9/6 per lb.	
" Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

	Export.
SCOTLAND.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	27/-
" " Ell	29/-
" " Splint	30/6 to 34/-
" " Trebles	30/6
" " Doubles	30/-
" " Singles	29/6
Ayrshire—	
(f.o.b. Ports)—Steam	27/-
" " Splint	30/6
" " Trebles	30/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	27/- to 31/-
Screened Navigation	34/-
Trebles	31/-
Doubles	30/-
Singles	29/9
Lothians—	
(f.o.b. Leith)—Best Steam	30/-
Secondary Steam	28/-
Trebles	31/-
Doubles	30/6
Singles	30/-
ENGLAND.	
(8) **N.W. Coast—**	
Steams	31/6
Household	46/6 to 57/6
Coke	48/-
Northumberland—	
Best Steams	34/6 to 35/-
Second Steams	32/6 to 33/6
Steam Smalls	23/- to 25/-
Unscreened	26/6
Household	25/- to 28/-
Durham—	
Best Gas	33/- to 35/-
Second	32/6
Household	25/- to 28/-
Foundry Coke	70/- to 75/-
Sheffield—	**Inland.**
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
" " House	23/- to 24/6 —
" " Large Nuts	20/6 to 22/6 —
" " Small "	18/- to 21/- —
Yorkshire Hards	22/- to 24/- —
Derbyshire "	21/- to 24/- —
Rough Slacks	12/- to 14/- —
Nutty "	10/6 to 12/6 —
Smalls	7/- to 9/- —
Blast Furnace Coke (Inland)	24/- to 27/-
" " " (Export) f.o.b.	44/- to 47/-

Cardiff— (9) **SOUTH WALES.**

Steam Coals:	
Best Smokeless Large	39/- to 41/-
Second " "	37/6 to 39/-
Best Dry Large	37/6 to 40/-
Ordinary Dry Large	35/- to 37/6
Best Black Vein Large	39/- to 40/-
Western Valley "	39/- to 40/-
Best Eastern Valley Large	38/- to 39/-
Ordinary " "	33/- to 35/-
Best Steam Smalls	30/- to 32/6
Ordinary "	25/- to 30/-
Washed Nuts	30/- to 35/-
No. 3 Rhondda Large	39/- to 40/-
" " Smalls	30/- to 32/6
No. 2 " Large	32/6 to 35/-
" " Through	30/- to 32/6
" " Smalls	26/- to 28/-
Coke (export)	70/- to 90/-
Patent Fuel	40 - to 45/-
Pitwood (ex ship)	29/6 to 30/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	45/- to 47/6
Seconds	42/6 to 45/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 55/-
Beans	47/6 to 50/-
Peas	25/- to 26/-
Breaker Duff	12/- to 13/-
Rubbly Culm	17/- to 17/6
Steam Coals:	
Large	27/6 to 30/-
Seconds	26/- to 27/-
Smalls	19/- to 25/-
Cargo Through	25/- to 27/6

(1) Delivered. (3) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Future.

OFFICIAL reports of the quantity of coke being sent from the Ruhr into France would imply that the situation of the iron smelting industry is greatly improving, and to the extent that a number of furnaces have been put in blast there would seem to be more hope for the future. Nevertheless, the recovery that was expected to take place is not so pronounced as might have been looked for, there being still a dearth of raw material. The feeling of confidence that was aroused by official statements emphasising the success attending the seizure of coke supplies in the Ruhr is giving way to considerable doubt as to the early future, for it is certain that the ovens are replenishing only a very small part of the stocks being cleared out of the district, and when the French have removed all the coke available the situation of blast-furnace proprietors may be worse than it was before they began to draw upon the stocks. Meanwhile, efforts are being made to increase the foreign supplies, and some consignments of coke have recently been obtained from the United States, but the American coke is found to be too friable for repeated handling, and it contains so much dust, that the experiment of importing coke from the other side of the Atlantic is not likely to be repeated. Supplies of British coke can be no longer relied upon in view of the statement that consignments to this country are to be limited. Special care is, therefore, being taken to enforce the new regulation prohibiting the export of scrap metal so long as there remains a dearth of raw material, and it is stated that the French Government has placed an embargo upon some thousands of tons of British shells which have been accumulating at the ports for shipment to England.

Foreign Trade.

Considering that so many blast-furnaces have been damped down during the past two months, and that the iron, steel and engineering trades have been struggling with a deficit of raw material, the improvement in the foreign trade, as shown in the returns for the first three months of the year, is remarkable. This is due, in the first place, to the return of Alsace and Lorraine, which has added enormously to the country's resources, and also to the industrial reconstruction in the northern districts, where the putting down of improved plants and machinery is greatly increasing the manufacturing facilities. Even under the present adverse conditions of trade the exports have been far in excess of the pre-war figures. The imports during the first three months were valued at 6974 million francs, or 1740 million francs more than in the first quarter of 1922. This was attributed almost entirely to raw material, although the quantity of raw material imported showed a slight diminution, the difference in value and weight being due to the fact that British coal had to be purchased at a high price to take the place of the German fuel which was stopped from coming into this country in the early stage of the Ruhr occupation. The exports were valued at 6499 million francs, representing an increase on the first quarter of last year of 1618 million francs, and here there was a notable increase all round, including manufactured goods, of which the value amounted to 3560 million francs. While the values of exports were only slightly less than those of imports they were, in weight, little more than one half, the imports totalling 12,082,499 tons and the exports 6,208,077 tons. This was partly due to the higher values of manufactured goods and partly to the fact that while imports are taken at their invoice values, the exports are valued according to an arbitrary scale fixed by the Customs. A comparison is, therefore, misleading, but the weights nevertheless show that the export trade is in constant progress.

Paris Extensions.

The population of Paris is so considerably in excess of what it was before the war that the housing problem would have been serious even in normal times, but when it is accompanied by a lack of building activity, there is obviously no hope of a solution except by a vast programme of construction. The Municipal Council has made a start by building houses for the working classes, but when 60,000 families are waiting for homes, the task is evidently beyond the powers of the Municipality. The real solution is thought to lie in a plan, which has long been before the Council, for joining up Paris with the suburbs and extending them outwards by the laying out of large areas with houses, garden cities, parks and industrial sites. The levelling of the fortifications is already preparing the way for this transformation, and the proposed extensions of the Metropolitan to the suburbs, as well as the electrification of the suburban railways, will facilitate traffic over a wide radius from the city. The plan is so vast that it can only be carried out over a very long period and with a huge expenditure of money, and when the programme has been approved by the Municipal Council, it is proposed to start upon its execution by means of a big public loan.

Transport.

The Commission appointed to examine the thirteen schemes which have been submitted for the installation of underground moving platforms in Paris has been unable to give preference to any one particular project, and has recommended the Municipal Council to lay down lengths of platforms of some of the different types proposed sufficiently long to allow of their being put to a thorough test. It is also proposed to install an experimental aerial railway from the Porte Maillot to Colombes. The advantages of an aerial railway as a means of facilitating suburban traffic without adding to the congestion of the roads have been under consideration for a year or two past, and some experimental work has been carried out to show that the system is feasible. As these tests appear to have given satisfactory results, the construction of a suburban aerial railway has been decided upon in principle.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

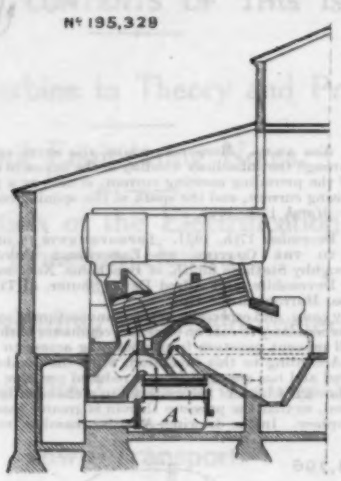
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

195,329. September 11th, 1922.—AIR HEATERS FOR BOILERS, Aktiebolaget Ljungströms Angturbin, Arsenalsgatan 2, Stockholm, Sweden.

The inventors claim that by arranging an air heater A in the position shown space usually wasted is occupied usefully, while the air passages are made exceptionally short. The scheme needs

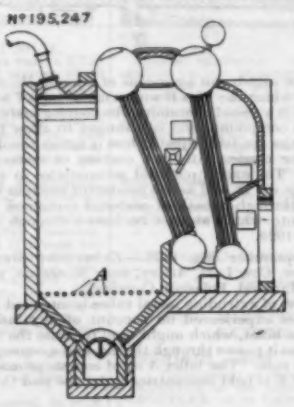


little description, as the arrows show the directions of the waste gases and the air to be heated, while the heater itself is of a form that has already been mentioned in these notes.—*March 29th, 1923.*

FURNACES.

195,247. March 2nd, 1922.—FURNACES FOR POWDERED FUEL, J. S. Atkinson and the Powdered Fuel Plant Company, Limited, 47, Victoria-street, Westminster.

The inventors propose to arrange a grid of perforated pipes A across the bottom of the combustion space of a furnace burning powdered fuel. The pipes are supplied with air under pressure

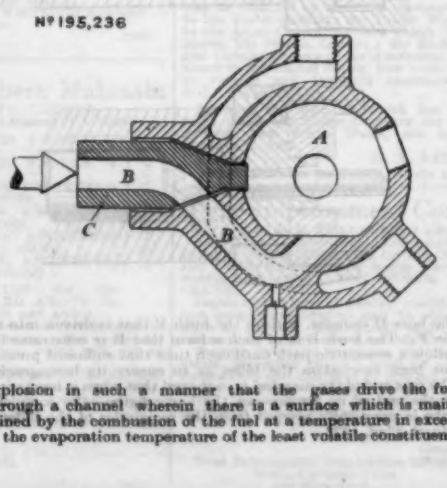


with the object of consuming the residues as much as possible and depositing them in the ashpit in the form of a fine powder.—*March 29th, 1923.*

INTERNAL COMBUSTION ENGINES.

195,236. February 17th, 1922. FUEL INJECTORS, J. Gattlen, Brigue, Switzerland.

According to this invention the fuel is introduced into the combustion chamber by means of the gases of a preliminary

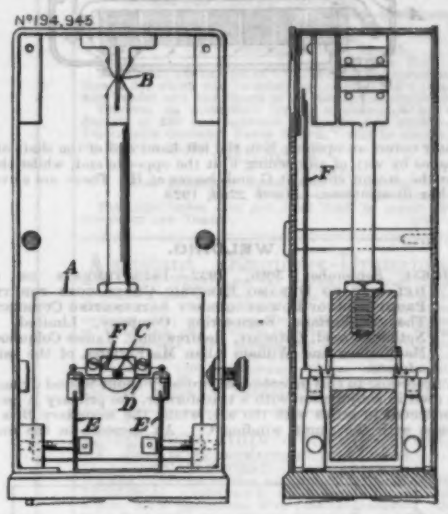


explosion in such a manner that the gases drive the fuel through a channel wherein there is a surface which is maintained by the combustion of the fuel at a temperature in excess of the evaporation temperature of the least volatile constituents of the fuel, so that under the combined action of the hot gases of the preliminary explosion and the heated surface the fuel is not only gasified, but is also for the greater part converted into combustible gases. A is the chamber in which the preliminary explosion takes place and thus drives the fuel oil along the passage B into the working cylinder. The passage is formed partly in the plug C, of such a metal as chrome-nickel steel, that becomes incandescent on account of the heat of the explosions. It will be noticed that the plug only touches the chamber casting where it is attached by a screw thread.—*March 29th, 1923.*

MEASURING AND TESTING INSTRUMENTS.

194,945. March 27th, 1922.—VIBRATION INDICATORS, *The British Thomson-Houston Company, Limited, Crown House, Aldwych, London, W.C. 2.*

This instrument is intended for detecting and measuring vibrations in one direction only. A heavy pendulum A is supported in a casing by means of a flat spring B. A spindle C, passing through a large hole in the pendulum, is supported by threads D that are wrapped once round it and fixed to columns

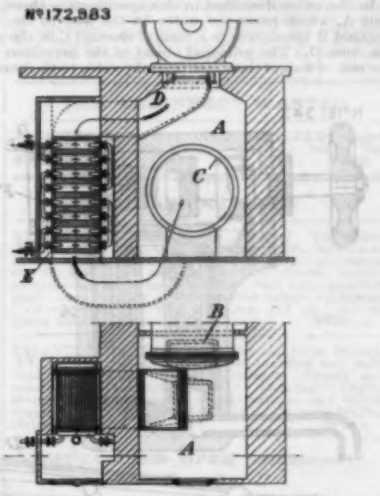


E E on the base. Other threads F, also wrapped round the spindle, are connected with the pendulum. The spindle carries a pointer F that moves over a graduated dial. The relative movement of the casing and pendulum caused by the vibrations causes a rolling action of the spindle along the threads and the pointer is displaced proportionately.—*March 22nd, 1923.*

DYNAMOS AND MOTORS.

172,983. December 20th, 1920.—IMPROVEMENTS IN APPARATUS FOR COOLING AND VENTILATING DYNAMO-ELECTRIC MACHINES, Willi Bartel, of Hugo-Schulzstrasse 1, and Otto Happel, of Wrangelstrasse 33, both of Bochum, Germany.

The air conduit leading from the cooling appliance to the air inlet has an enlargement, the cross section of which is substantially greater than that of any part of the air conduit leading from the air outlet of the machine to the cooling appliance. This enlargement forms a chamber in which the air velocity is



substantially reduced in a manner which is conducive to the separation of liquid particles carried by the air so that moisture is prevented from entering the machine. In the drawings the enlarged chamber is shown at A, B is the air inlet to the machine, C the turbine condenser, D the hot air conduit, and E the cooler. —*March 19th, 1923.*

193,056. December 19th, 1921.—IMPROVEMENTS IN OR RELATING TO THE METHOD OF COOLING TURBINE-DRIVEN DYNAMO-ELECTRIC MACHINES, Willi Bartel, of Hugo-Schulzstrasse 1, and Otto Happel, of Wrangelstrasse 33, both of Bochum, Germany.

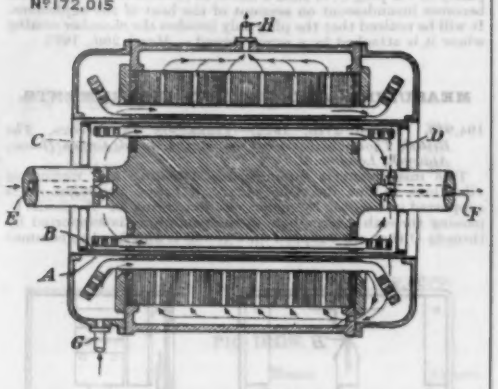
Turbo-dynamos are commonly cooled by means of an air current, the usual method being to use a confined circulating air current, which flows through a water-cooled cooling appliance. It has been found that with suitably proportioned cooling surfaces the quantity of water required in the air cooler is approximately equal to the quantity required for replacing that portion of the circulating cooling water of the turbine condenser. According to this invention the supplementary water is first used for cooling the circulating air current and is then added to the cooling water of the condenser. Thus the cost of working the air cooler is practically eliminated.—*March 19th, 1923.*

172,015. November 22nd, 1921.—IMPROVEMENTS RELATING TO LIQUID-COOLED ELECTRIC MACHINES, Michael Seidner, of 5, Zeigmond utca Budapest, Hungary.

The stator and rotor of the machine described in this specification are separated by a tube A which is fastened to the end shields

and passes through the air gap. A second tube B encloses the rotor and terminates in end discs C and D. In this way the two parts of the machine are separated from one another, so that the liquid contained by one part cannot come in contact with that in the other part. It will be seen that the cooling liquid for the

No 172,015



rotor enters an opening E in the left-hand end of the shaft and leaves by way of an opening F at the opposite end, whilst that for the stator enters at G and leaves at H. There are eleven other illustrations.—*March 22nd*, 1923.

WELDING.

194,634. September 30th, 1922.—Improvements in or Relating to Dynamo Electric Generators for the Production of Low-frequency Alternating Currents, The MacFarlane Engineering Company, Limited, of Netherlee-road, Cathcart, Renfrewshire, James Colquhoun MacFarlane and William Allan MacFarlane, of the same address.

According to this invention an ordinary shunt-wound dynamo is used in conjunction with a transformer, the primary A being connected in series with the arc, whilst the secondary B is in series with the shunt winding C. An increase in the main

No 194,634

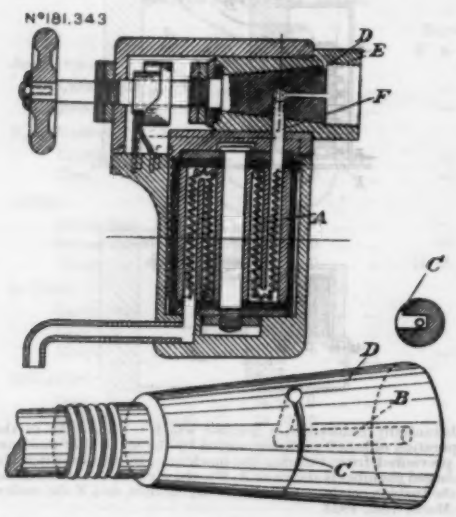
current causes a momentary increase in the secondary voltage and the main field of the generator is opposed. If the induced current in the secondary increases beyond that of the main field the dynamo acts as a low-frequency alternator.—*March 15th*, 1923.

LIGHTING AND HEATING.

181,343. May 26th, 1921.—Improvements in and relating to Electric Water Heating Apparatus, Hydrotherm Fabrik Elektrischer Apparate G.m.b.H., of 10, Schönhawserstrasse, Berlin, C 54.

In the valve described in this specification there is a heating unit A, which heats the water on the way to the valve. The channel B terminates in a conical channel C in the periphery of the cone D. The principal object of the invention is to enable he rate of flow of the water from the valve to the heating element

No 181,343



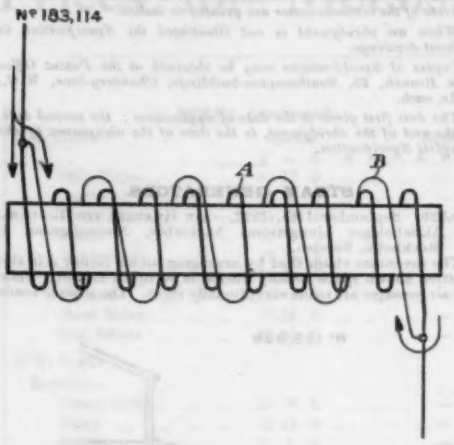
to be accurately regulated, thus permitting the quantity of water passing and the temperature of the water discharged from the heating unit to be varied in accordance with requirements. The port E is connected to the existing water supply pipe and the conical channel regulates the flow of water in the pipe F.—*March 22nd*, 1923.

MISCELLANEOUS.

183,114. July 9th, 1921.—Improvements in the Windings of Direct-current Electro-magnets, "Scintilla," of Solothurn, Switzerland.

This invention relates to a winding for direct-current electro-magnets, the exciting current in which has to be switched on and shut off at frequent intervals. With an ordinary winding it often happens that the magnetic field does not disappear with sufficient rapidity when the current is switched off. The object of this invention is to overcome this defect and to avoid the injurious effect of the extra induced voltage. The core is provided with a main winding A, to which a subsidiary winding B is connected in parallel, and is wound in the same direction. The high induced voltage is led away in the winding B, and so

No 183,114

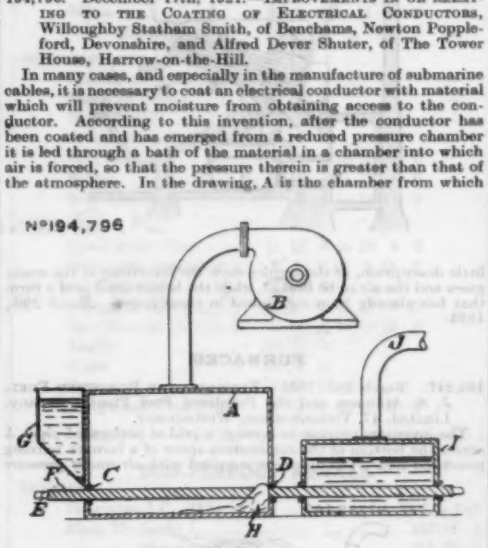


gradually dies away. Moreover, whilst the extra current is flowing through the subsidiary winding in the opposite direction to that of the preceding exciting current, it acts as a powerful demagnetising current, and the spark at the opening contacts is damped.—*March 15th*, 1923.

194,796. December 17th, 1921.—Improvements in or relating to the Coating of Electrical Conductors, Willoughby Statham Smith, of Benchams, Newton Poppleford, Devonshire, and Alfred Dever Shuter, of The Tower House, Harrow-on-the-Hill.

In many cases, and especially in the manufacture of submarine cables, it is necessary to coat an electrical conductor with material which will prevent moisture from obtaining access to the conductor. According to this invention, after the conductor has been coated and has emerged from a reduced pressure chamber it is led through a bath of the material in a chamber into which air is forced, so that the pressure therein is greater than that of the atmosphere. In the drawing, A is the chamber from which

No 194,796

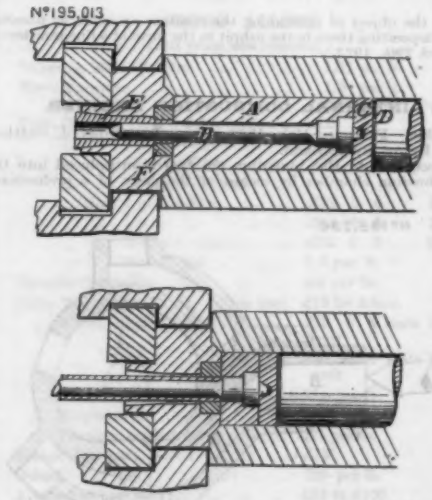


the air can be withdrawn by means of a pump B. C and D are dies through which the wire E with a metal tape F wound round it passes. G is a vessel containing the coating material, such as gutta-percha compound, and is arranged to allow the material to fall on to the conductor just before it enters the die C so that the conductor carries with it a coating of material into the chamber A. The excess material accumulates in a heap at H in front of the die D, and as the conductor emerges from the die D it passes through a bath of material contained in a second chamber I into which air can be forced through a pipe J.—*March 10th*, 1923.

195,013. September 6th, 1922.—Extruding Metal Tubes, E. Player, Cow Lees, Astley, near Nuneaton, and Sterling Metals, Limited, Foleshill, Coventry.

This process of extruding metal tubes is intended to eliminate the difficulties experienced on account of any lack of homogeneity in the billet, which might tend to cause the deflection of the mandrel as it passes through the die, and a consequent excentricity of the tube. The billet A is, of course, primarily pierced. The mandrel B is held concentrically by the pad C, with which

No 195,013



the boss D engages, and by the bush E that is driven into the die F. The bush E is of such a form that B is constrained to follow a concentric path until such time that sufficient pressure has been exerted on the billet as to ensure its homogeneity. The rear end of the mandrel is so shaped that when it has arrived at the end of its stroke—see the lower figure—the completed tube is practically severed from the remainder of the billet.—*March 22nd*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Metals: Sheffield Local Section.—Mappin Hall of the University, St. George's-square, Sheffield. Annual general meeting. 7.30 p.m.

Institution of Electrical Engineers: Scottish Centre.—The Technical Institute, Dundee. Paper, "The Drive of Power Station Auxiliaries," by Messrs. L. Breach and H. Midgley. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Informal discussion on "The Use of Light Alloys in Place of Iron and Steel," by Mr. A. E. L. Chorlton. 7 p.m.

Institution of Municipal and County Engineers.—Joint meeting of the Eastern and Metropolitan Districts at Boxmoor, Herts.

Institution of Production Engineers.—The Engineers' Club, Coventry-street, W. 1. Paper, "The Efficient Tooling of Automatics," by Mr. L. C. Keen. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Stock Control," by Mr. J. Fearn. 7.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Measurement of the Heating Value of Gas," by Mr. C. V. Boys. 9 p.m.

MONDAY, APRIL 30TH.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Howard Lecture. "The Development of the Steam Turbine," by Mr. Stanley S. Cook. 8 p.m.

TUESDAY, MAY 1ST.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Annual meeting. 5 p.m.

WEDNESDAY, MAY 2ND.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. "The Design of Inductances for High-frequency Circuits," by Professor C. L. Fortescue. 6 p.m.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Thirteenth annual May Lecture on "The Inner Structure of Alloys," by Dr. W. Rosenhain, F.R.S. 8 p.m.

THURSDAY, MAY 3RD.

Institution of Sanitary Engineers.—Caxton Hall, Westminster, S.W. 1. "The Relationship between Insanitation and Disease," by Dr. Walter R. Hawden. 6.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. "Modern Electric Lamps: II., Glowing Solids in Gases," by Professor J. T. MacGregor Morris. 3 p.m.

FRIDAY, MAY 4TH.

Chemical Engineering Group.—The Engineers' Club, 39, Coventry-street, W. 1. Annual general meeting and dinner. 6.30 p.m.

Institute of Metals.—University College, Singleton Park, Swansea. Annual general meeting. 7.15 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Twenty-ninth James Forrest Lecture entitled "The Interdependence of Abstract Science and Engineering," by Sir Richard T. Glazebrook. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "A.C. Neutral Point Earthing," by Mr. S. A. Stigant. 7.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Origins of the Conception of Isotopes," by Professor Frederick Soddy. 9 p.m.

MONDAY, MAY 7TH.

Society of Engineers.—The Geological Society, Burlington House, Piccadilly, W. 1. "Pneumatic Handling of Petrol and other Inflammable Liquids," by Pierre Mauclère. 5.30 p.m.

THURSDAY AND FRIDAY, MAY 10TH AND 11TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. For programme, see page 401. 10 a.m. each day.

FRIDAY, MAY 11TH.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Durham Bursar's Lecture, "The Theory of Resistance to the Flow of Gases and Fluids in Pipes," by Mr. W. F. C. Cooper. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. Harry Parsons, of the Parsons Motor Company, Limited, of Southampton, has been elected chairman of the Southampton Harbour Board.

We are advised by James Gordon and Co., Limited, that they have recently acquired the licence for the manufacture and sale in Great Britain of the Duplex Mono recorder.

John A. Smeeton, Limited, informs us that it has removed its offices from 56, Victoria-street, to St. Stephen's House, Victoria Embankment, Westminster, London, S.W. 1.

Smeeton-Wright Furnaces, Limited, inform us that they have removed their offices from 56, Victoria-street, to St. Stephen's House, Victoria Embankment, Westminster, London, S.W. 1.

Presentation at Middlewich.—A presentation of a chiming clock was recently made by the whole of the employees of Electro Bleach and By-products, Limited, of Middlewich, Cheshire, to Mr. Stainer Hutchins, the managing director of the company. The object of the presentation was to give expression to the good feeling which exists and the pleasure which is felt at Mr. Hutchins' decision to continue his connection with the company. The presentation was made by Mr. Stephens, chairman of the Works Committee. In accepting the gift, Mr. Hutchins referred to the progress of the company during the past nine years and to the good feeling existing between himself and the employees, the relationship being that of a happy family. He thanked them for the handsome gift, which would at all times remind him of his happy associations with Middlewich.